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CNC CHARLESTON
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CORRECTIVE MEASURES STUDY REPORT SOLID WASTE MANAGEMENT UNIT (SWMU 8) AREA OF CONCERN 636 (AOC 636) ZONE G CNC CHARLESTON SC
6/16/2003
CH2M HILL

CORRECTIVE MEASURES STUDY REPORT

SWMU 8/AOC 636, Zone G

Charleston Naval Complex
North Charleston, South Carolina

SUBMITTED TO
U.S. Navy Southern Division
Naval Facilities Engineering Command

PREPARED BY
CH2M-Jones

June 2003

Contract N62467-99-C-0960

CH2MHILL

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June 16, 2003

Mr. David Scaturo
South Carolina Department of Health and
Environmental Control
Bureau of Land and Waste Management
2600 Bull Street
Columbia, SC 29201

Re: CMS Report (Revision 0) – SWMU 8/AOC 636, Zone G

Dear Mr. Scaturo:

Enclosed please find two copies of the CMS Report (Revision 0) for SWMU 8/AOC 636 in Zone G of the Charleston Naval Complex (CNC). This report has been prepared pursuant to agreements by the CNC BRAC Cleanup Team for completing the RCRA Corrective Action process.

The principal author of this document is Casey Hudson. Please contact him at 407/423-0030, ext. 251, if you have any questions or comments.

Sincerely,

CH2M HILL

Dean Williamson, P.E.

cc: Tim Frederick/Gannett Fleming, Inc., w/att
Dann Spariosu/USEPA, w/att
Rob Harrell/Navy, w/att
Gary Foster/CH2M HILL, w/att

CORRECTIVE MEASURES STUDY REPORT

SWMU 8/AOC 636, Zone G

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Revision 0
Contract N62467-99-C-0960
158814.ZG.PR.09

Certification Page for Corrective Measures Study Report (Revision 0) — SWMU 8/AOC 636, Zone G

I, Dean Williamson, certify that this report has been prepared under my direct supervision. The data and information are, to the best of my knowledge, accurate and correct, and the report has been prepared in accordance with current standards of practice for engineering.

South Carolina

P.E. No. 21428

Dean Williamson

Dean Williamson, P.E.

6/12/2003

Date

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Contents, Continued

Acronyms and Abbreviations

AOC	Area of Concern
AFVR	Aggressive Fluid Vapor Recovery
BRAC	Base Realignment and Closure
CA	Corrective Action
CMS	Corrective Measures Study
CMSWP	Corrective Measures Study Work Plan
CNC	Charleston Naval Complex
COC	Chemical of concern
COPC	Chemical of potential concern
DAF	Dilution attenuation factor
DET	Environmental Detachment Charleston
DO	Dissolved oxygen
EnSafe	EnSafe Inc.
EPA	U.S. Environmental Protection Agency
ft bls	Feet below land surface
ft msl	Feet mean sea level
Hg	Mercury
HI	Hazard index
ILCR	Incremental lifetime cancer risk
IM	Interim measure
LNAPL	Light non-aqueous phase liquid
LUCIP	Land Use Control Implementation Plan
LUC	Land use control
MCL	Maximum contaminant level
MCS	Media cleanup standard
MDL	Method detection limit
$\mu g/L$	Microgram per liter

Acronyms and Abbreviations, Continued

mg/kg	Milligram per kilogram
MNA	Monitored natural attenuation
NAVBASE	Naval Base
NFA	No Further Action
NTU	Nephelometric turbidity unit
O&M	Operation and maintenance
ORP	Oxygen reduction potential
OSWER	Office of Solid Waste and Emergency Response
PAHs	Polycyclic aromatic hydrocarbons
PCA	Tetrachloroethane
PCB	Polychlorinated biphenyl
PRB	Permeable reactive barrier
Qc	Quaternary Clay
Qm	Quaternary Marsh
Qs	Quaternary Sand
RAO	Remedial action objective
RBC	Risk-based concentration
RCRA	Resource Conservation and Recovery Act
RFI	RCRA Facility Investigation
RFIRA	RCRA Facility Investigation Report Addendum
RGO	Remedial goal option
SCDHEC	South Carolina Department of Health and Environmental Control
SSL	Soil screening level
SVOC	Semivolatile organic compound
SWMU	Solid Waste Management Unit
Ta	Ashley Formation
TSCA	Toxic Substances Control Act

Acronyms and Abbreviations, Continued

UST	Underground storage tank
UXO	Unexploded ordnance
VOC	Volatile organic compound

Section 1.0

1.0 Introduction

In 1993, Naval Base (NAVBASE) Charleston was added to the list of bases scheduled for closure as part of the Defense Base Realignment and Closure (BRAC) Act, which regulates closure and transition of property to the community. The Charleston Naval Complex (CNC) was formed as a result of the dis-establishment of the Charleston Naval Shipyard and NAVBASE on April 1, 1996.

CNC Corrective Action (CA) activities are being conducted under the Resource Conservation and Recovery Act (RCRA); the South Carolina Department of Health and Environmental Control (SCDHEC) is the lead agency for CA activities at the site. All RCRA CA activities are performed in accordance with the Final Permit (Permit No. SC0 170 022 560). In April 2000, CH2M-Jones was awarded a contract to provide environmental investigation and remediation services at the CNC.

A RCRA Facility Investigation (RFI) Report Addendum and Corrective Measures Study (CMS) Work Plan (RFIRA/CMSWP) were prepared for Solid Waste Management Unit (SWMU) 8 and Area of Concern (AOC) 636 in Zone G at the CNC (CH2M-Jones, 2003). The RFIRA/CMSWP presented the remedial action objectives (RAOs) and media cleanup standards (MCSs) proposed for SWMU 8/AOC 636. The RFIRA/CMSWP was approved by the U.S Environmental Protection Agency (EPA) Region IV on behalf of SCDHEC on April 9, 2003. This CMS report has been prepared by CH2M-Jones to complete the next stage of the CA process for SWMU 8/AOC 636. Figure 1-1 presents the location of SWMU 8/AOC 636 and Zone G within the CNC.

1.1. Corrective Measures Study Report Purpose and Scope

This CMS report evaluates corrective measure alternatives for addressing contamination from light non-aqueous phase liquid (LNAPL), polycyclic aromatic hydrocarbons (PAHs), and antimony present in the shallow portion of the surficial aquifer, and Aroclor-1260, thallium, and antimony in soil at SWMU 8/AOC 636.

This CMS report consists of: 1) the identification of a set of corrective measure alternatives that are considered to be technically appropriate for addressing LNAPL recovery and soil and groundwater contaminated with chemicals of concern (COCs); 2) an evaluation of the alternatives using standard criteria from EPA RCRA guidance; and 3) the selection of recommended (preferred) corrective measure alternatives for the site. This focused CMS evaluates the options for meeting the RAOs, which are described in Section 2.0 of this CMS report.

1.2 Background Information

1.2.1 Facility Description

AOC 636, which is located immediately east of Brumby Street, lies within the western boundary of SWMU 8. SWMU 8 and AOC 636 are bounded by Hobson Avenue to the north, Dyess Avenue to the south, Brumby Street to the west, and Building X-10 and AOC 642 to the east. AOC 642, a former pistol range located south of RFIRA for AOC 642, issued by CH2M-Jones on February 1, 2002, recommended No Further Action (NFA) status for the site. This recommendation was subsequently approved by SCDHEC on March 6, 2002.

SWMU 8 contained three unlined oil sludge pits that were used to dispose oil sludge from 1944 to 1977. The pits were later filled and in 1997 were excavated as part of an interim measure (IM). The area is currently open with gravel and soil cover. AOC 636 is a former torpedo magazine, where torpedoes and munitions were stored in the 1940s. Currently, the AOC 636 area contains Building 161 and an asphalt-paved parking lot. Figure 1-2 shows the location of the SWMU 8/AOC 636 site within Zone G. In addition, Figure 1-2 depicts the IM soil excavation areas.

1.2.2 Interim Measure by the DET

From March to September 1997, the Environmental Detachment Charleston (DET) removed 26,533 tons of non-hazardous oil-impacted soil and 50,000 gallons of recovered oil in two separate areas of the SWMU 8/AOC 636 site. The objective of the IM was to remove through excavation the source of contamination (i.e., visible sludge), heavily contaminated soil, and LNAPL. As there were no MCSs for the excavated material, the excavation of oil-impacted soil was completed to a visual standard.

IM execution was separated into two areas. Area 1 contained two smaller oil sludge pits, and Area 2 contained a pit with LNAPL. According to the *Completion Report, Interim Measure for SWMU 8* (DET, 1999), Area 1 was dewatered in 1974 and covered with clean fill material. Area 2 was filled with debris and covered in 1955. Figure 1-3 depicts these two areas.

From October 21, 1997 to September 3, 1999, approximately 50,000 gallons of LNAPL were recovered from Area 2. Area 2 was filled with Number 57 granite from the bottom to an elevation of approximately 5 feet below land surface (ft bls) (i.e., groundwater elevation). A layer of geofabric was then installed followed by 5 feet of soil fill with a 4-inch gravel layer at the surface. Eighteen 12-inch diameter groundwater sumps, identified as G008GSP001 through G008GSP018, placed on 50-ft centers, were installed to an approximate depth of 10 ft bls to allow for further LNAPL recovery, if necessary. The locations of these 18 groundwater sumps are depicted on Figure 1-3.

As part of the IM objective, AOC 636 was investigated for buried unexploded ordnance (UXO). According to the *Zone G RFI Report, Revision 0* (EnSafe, 1998), no historical evidence of repair operations or disposal occurring at this facility exists. An UXO subcontractor performed geophysical screening of the RFI sampling locations for buried UXO, but found no anomalies. In addition, no UXO, torpedo parts, or other visual evidence of disposal were observed during the soil excavation IM completed at SWMU 8 in the southwest corner of AOC 636. Based on this information, the CNC Project Team and the DET determined that there was no need for a formal UXO survey.

1.2.3 Summary of RFI

SWMU 8/AOC 636 was previously investigated by the Navy/EnSafe team during the Zone G RFI, which was completed in 1998. In accordance with the *Zone G RFI Work Plan Addendum* (EnSafe, 2000), additional surface (0 to 1 ft bls) and subsurface soil (3 to 5 ft bls) samples were collected in December 1999 in the area of AOC 636 to further delineate the extent of semivolatile organic compounds (SVOCs), metals, and hydrazine. In addition, as recommended in the *Sampling and Analysis Plan, AOC 636, Zone G, Revision 0* (CH2M-Jones, 2001), subsurface soil samples were collected in July 2001 by CH2M-Jones to further delineate metals and 1,1,2,2-tetrachloroethane (1,1,2,2-PCA) in the area of AOC 636. The results of these additional RFI sampling investigations were summarized in the RFIRA/CMSWP (CH2M-Jones, 2003).

Subsequent to the submittal of the *Zone G RFI Report, Revision 0* (EnSafe, 1998), one or a series of the site monitoring wells were sampled during 10 events from December 1997 to August 2002. One additional deep monitoring well, identified as G004GW04D, was installed on August 22, 2002. The site monitoring wells, including the location of this deep monitoring well, are depicted on Figure 1-3. The results of these additional groundwater sampling events are summarized in the RFIRA/CMSWP (CH2M-Jones, 2003).

1.2.4 Site Hydrogeology

The lowermost stratigraphic unit identified in Zone G is the Ashley Formation (Ta) member of the Mid-Tertiary age Cooper Group. According to the *Zone G RFI Report, Revision 0*, the

Ta was encountered throughout Zone G at elevations ranging from –16.6 to –49 feet mean sea level (ft msl) and is higher in the eastern portion of Zone G than in the western and southern portions. The Ta is a tight, slightly calcareous, clayey silt with varying amounts of fine-grained sand which decreases rapidly with depth.

Overlying the Ta are younger Upper-Tertiary and Quaternary-age stratigraphic units. The Quaternary-age sediments range from 25 to 55 feet thick. During the RFI field activities three distinct Quaternary-age litho-stratigraphic units were identified as Quaternary Clay (Qc), Quaternary Marsh (Qm), and Quaternary Sand (Qs). The Qc deposits consist of a stiff very fine to fine grained sandy and silty clay. The Qc unit was commonly found in the upper 10 to 15 feet of the shallow subsurface. The Qm is a soft, sticky clay, occasionally laminated with sand, silt, and shelly lenses. It has a high organic content, low plasticity, and a distinctive hydrogen sulfide odor. According to the *Zone G RFI Report, Revision 0*, the Qm is approximately 45 feet thick in the southeastern portion of Zone G and decreases to approximately 7 feet thick in the western portion. The uppermost unit, the Qs, is primarily very fine to medium silty sand, well to moderately well sorted and loose. The Qs deposits in Zone G range from thin lenses (0.5 to 1.7 feet) to thicker lenses (4 feet).

Groundwater elevations in the immediate area of SWMU 8/AOC 636 are tidally influenced and range from –0.5 to 5 ft msl. As reported in the *Zone G RFI Report, Revision 0*, groundwater flow in the surficial aquifer is variable in gradient and direction, with a groundwater depression existing outside the north corner boundary of AOC 636. Figure 1-4 presents a potentiometric surface map using groundwater elevation data collected on March 15, 2002.

1.2.5 Nature and Extent of Contamination

The following COCs were identified at the site during the RFI stage.

Media	COCs
Groundwater	LNAPL, PAHs, Antimony
Surface Soil	Aroclor-1260 (unrestricted land use), Thallium (leaching potential)
Subsurface Soil	Antimony and Thallium (leaching potential)

Each of these COCs are briefly discussed below.

LNAPL

On October 18, 2002, the 18 groundwater sumps (i.e., G008GSP01 through G008GSP18) were gauged for LNAPL. An LNAPL thickness of 2.91 and 0.01 feet was measured in groundwater sumps G008GSP04 and G008GSP11, respectively. These groundwater sumps are shown on Figure 1-3. LNAPL was not observed in the other sumps at the site.

To identify the nature and type of LNAPL at SWMU 8, samples were collected from G008GSP04 and G008GSP11 during the March 2002 sample collection event and analyzed for polychlorinated biphenyls (PCBs); fingerprint analysis (hydrocarbons as heavy oil, diesel oil, and gasoline; mineral spirits; kerosene; naphtha); and hydrazine. Based on this analysis, the LNAPL appears to be a diesel or heavy-end fuel oil based on the elevated concentrations of hydrocarbons characteristic of diesel and heavy oil. This identification is consistent with the general lack of detection in groundwater of benzene, toluene, ethylbenzene, and xylenes (BTEX), which are associated with lighter fuels such as gasoline.

Groundwater COCs

Benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, and naphthalene were identified in the RFIRA/CMSWP as groundwater COCs. Detections of these PAHs most often occurred in groundwater samples collected from the sumps located in the former waste oil trenches. In addition, antimony was identified as a groundwater COC since it was detected at concentrations exceeding its maximum contaminant level (MCL) in one well.

Benzo[a]anthracene was detected at estimated concentrations in two of the 60 groundwater samples collected from the SWMU 8/AOC 636 monitoring wells. These two estimated concentrations of 2 J and 1 J μg/L detected in the samples collected from G008GSP11 and G008GSP12, respectively, were above the EPA Region III tap water risk-based concentration (RBC) (HI=0.1) of 0.092 μg/L. Figure 1-5 depicts a historic representation of benzo[a]anthracene in groundwater at SWMU 8/AOC 636.

Benzo[a]pyrene was detected at estimated concentrations in three of the 60 groundwater samples collected from the SWMU 8/AOC 636 monitoring wells. These three estimated concentrations of 1 J micrograms per liter (μg/L), 0.65 J μg/L, and 0.47 J μg/L, detected in the samples collected from G008GSP11, G008GW006, and G008GW005, respectively, were above the MCL of 0.2 μg/L. Figure 1-6 depicts a historic representation of benzo[a]pyrene in groundwater at SWMU 8/AOC 636.

Benzo[b]fluoranthene was detected at estimated concentrations in three of the 60 groundwater samples collected from the SWMU 8/AOC 636 monitoring wells. These three estimated concentrations of 1 J μg/L, 0.47 J μg/L, and 0.35 J μg/L detected in the samples collected from G008GSP11, G008GW006, and G008GW005, respectively, were above the EPA Region III tap water risk-based concentration (RBC) (hazard index [HI]=0.1) of 0.092 μg/L. These estimated concentrations are very similar to the benzo[a]pyrene groundwater results from the samples collected from the same monitoring wells during the same events. Figure 1-7 depicts a historic representation of benzo[b]fluoranthene in groundwater at SWMU 8/AOC 636.

Naphthalene was detected above its screening criteria in seven of the 60 groundwater samples collected from the SWMU 8/AOC 636 monitoring wells. A concentration of 28 μg/L was detected in the sample collected from G008GSP15; the detected concentrations in the remaining six samples range from 1 J to 5 J μg/L. These six estimated concentrations do not exceed the EPA Region III tap water RBC (HI=1.0) of 6.5 μg/L. Five of the seven concentrations were from groundwater sump samples. Naphthalene was not detected in subsequent samples collected from monitoring wells G008GW002 and G008GW006, in which naphthalene had been detected at estimated concentrations above its EPA Region III tap water RBC (HI=0.1) of 0.65 μg/L. Figure 1-8 depicts a historic representation of naphthalene in groundwater at SWMU 8/AOC 636.

Antimony was detected at estimated concentrations of 11J μg/L (March 29, 2002), 12.6 μg/L (May 21, 1997), and 22.6 J μg/L (November 15, 1996) in samples collected from G008GW003. These detected concentrations exceed the corresponding MCL for antimony of 6 μg/L and Zone G background range of 3 to 6 μg/L. However, except for the initial sample collected in November 1996, antimony did not exceed the EPA Region III tap water RBC (HI=1.0) of 15 μg/L. Antimony was detected above method detection limits (MDLs) in only one other groundwater sample (2.1 μg/L; GFDSGW02C) collected during the site sampling events. Figure 1-9 depicts a historic representation of antimony in groundwater at SWMU 8/AOC 636.

Surface Soil COCs

Based on an evaluation of the surface soil data as presented in the RFIRA/CMSWP, Aroclor-1260 and thallium were retained as COCs in surface soil for the unrestricted land use scenario.

The PCB Aroclor-1260 was detected in two of the 40 samples (0.84 J mg/kg in GFDSSC012 and 0.92 mg/kg in G636SB008) above its EPA Region III residential RBC of 0.32 milligrams per kilogram (mg/kg). These concentrations are below the industrial RBC of 2.9 mg/kg, and the preliminary remediation goal of 1 mg/kg established for PCBs based on the *Guidance on*

Remedial Actions for Superfund Sites with PCB Contamination (EPA, 1990). Aroclor-1260 was detected in only eight of the 40 surface soil samples (i.e., 20-percent occurrence) collected from the SWMU 8/AOC 636 site and outside the IM excavation areas. Figure 1-10 depicts Aroclor-1260 in surface soil at SWMU 8/AOC 636.

Thallium was detected in one of the 46 samples (0.92 J mg/kg in G636SB003) above its EPA Region III residential RBC of 0.55 mg/kg and the Zone G background range of 0.55 to 0.91 mg/kg. This detected concentration is similar to the background concentration, and is two orders of magnitude less than the EPA Region III industrial RBC (HI=0.1) of 14 mg/kg. Thallium was detected in only four of the 46 surface soil samples (i.e., 8.7-percent occurrence) collected from the SWMU 8/AOC 636 site outside the former IM excavation areas. These four concentrations, ranging from 0.42 J in G636SB002 to 0.92 J in G636SB003, were above its soil screening level (SSL) (dilution attenuation factor [DAF]=10) of 0.35 mg/kg. The mean thallium concentration in surface soil is 0.84 mg/kg when non-detects are included at half the MDLs. Therefore, thallium was retained as a COC due to leaching concerns. Figure 1-11 depicts thallium in surface soil at SWMU 8/AOC 636.

Subsurface Soil COCs

Based on the chemical of potential concern (COPC) refinement process presented in the RFIRA/CMSWP (CH2M-Jones, 2003), antimony and thallium were retained as COCs in subsurface soil. During the additional RFI sampling investigation completed by the Navy/EnSafe team, antimony was detected at concentrations of 4 J and 47.5 mg/kg in the subsurface soil samples collected from sample locations G636SB015 and G636SB019, respectively. In addition, during the 1993 pre-RFI sampling event, antimony was detected at concentrations of 32 mg/kg, 23 J mg/kg, and 21 J mg/kg in the subsurface soil samples collected from locations G008SB03, G008SB22, and G008SB24, respectively. These concentrations are above the corresponding SSL (DAF=10) of 2.5 mg/kg. These concentrations were also greater than the Zone H background concentration range of 1.5 to 19 mg/kg. The site mean antimony concentration in subsurface soil is 6.14 mg/kg when non-detects are used at half the MDLs. Antimony was detected in only seven of the 25 subsurface soil samples (i.e., 28-percent occurrence) collected from the SWMU 8/AOC 636 site outside the former IM excavation areas. Figure 1-12 depicts antimony in subsurface soil at SWMU 8/AOC 636.

Thallium was detected in one subsurface soil sample above its screening criteria. This subsurface soil sample collected from G636SB019 had a detected concentration of 3.8 mg/kg, which is above its corresponding SSL (DAF=10) of 0.35 mg/kg and the Zone G subsurface soil samples (i.e., 23-percent occurrence) collected from the SWMU 8/AOC 636 site outside the former IM excavation areas. The site mean concentration of thallium in subsurface soil is 0.85 mg/kg. This value is above the generic SSL (DAF=10) of 0.35 mg/kg. Figure 1-13 depicts thallium in subsurface soil at SWMU 8/AOC 636.

1.3 Report Organization

This CMS report consists of the following sections, including this introductory section:

1.0 Introduction — Presents the purpose and scope of the CMS, as well as relevant background information including site history, site hydrogeology, nature and extent of contamination, and summary of the risk assessment; most notably the COCs identified at the site.

2.0 Remedial Goal Options and Proposed Media Cleanup Standards — Presents the RGOs of this CMS and presents proposed MCSs for soil, groundwater, and LNAPL.

3.0 Overall Approach for Evaluating Focused Alternatives for SWMU 8/AOC 636 — Describes the alternative development process and presents the detailed evaluation criteria.

4.0 Description of Candidate Corrective Measure Alternatives — Describes each of the candidate corrective measure alternatives for LNAPL and impacted soil and groundwater at SWMU 8/AOC 636.

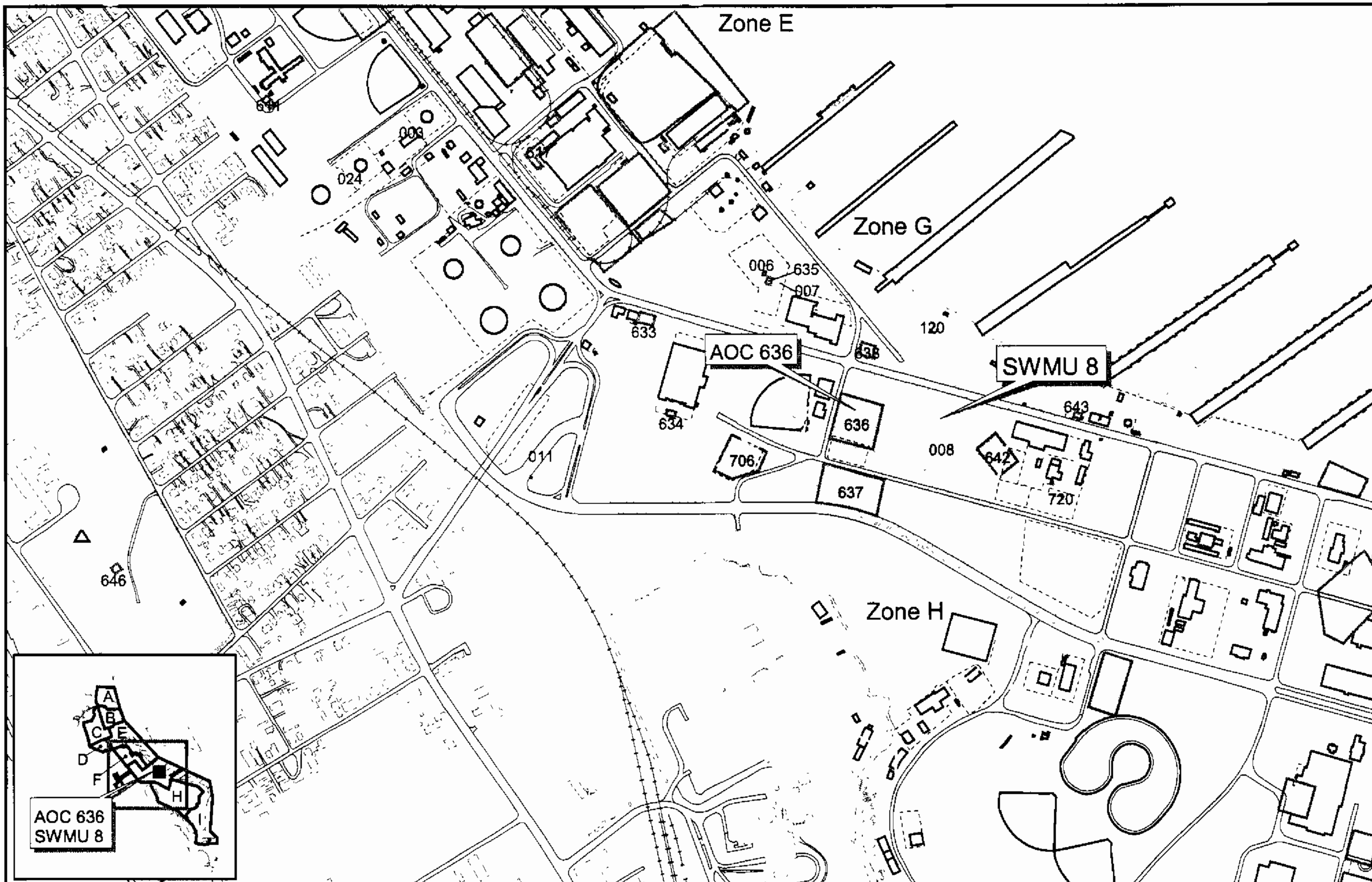
5.0 Detailed Evaluation of Alternatives — Presents the applicable treatment technologies considered for LNAPL recovery and a description of the technology screening process. The section also summarizes the factors and methodology used to evaluate and rank the corrective measure alternatives and the results of the evaluation.

6.0 Recommended Corrective Measure Alternatives — Describes the preferred corrective measure alternative to achieve the MCSs and remedial goal options (RGOs) for LNAPL and impacted soil and groundwater at SWMU 8/AOC 636 based on a comparison of the alternatives.

7.0 References — Lists the references used in this document.

Appendix A provides manufacturer's literature for a solar powered skimmer unit.

Appendix B provides the cost estimates for each corrective measure alternative evaluated in this CMS.



Fence
Railroads
Roads
Shoreline
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary
Zone G

N

0 800 1600 Feet

1 inch = 750 feet

Figure 1-1
Site Location
SWMU 8/AOC 636, Zone G
Charleston Naval Complex

CH2MHILL

File Path C:\18gis\Projects\Zone_G\zoneg_locationfig.apr, Date: 26 Sep 2002 11:45, User: NMOUDRY, SWMU 8 Figure 1-1 Zone G within CNC

NOTE: Aerial Ph 1997
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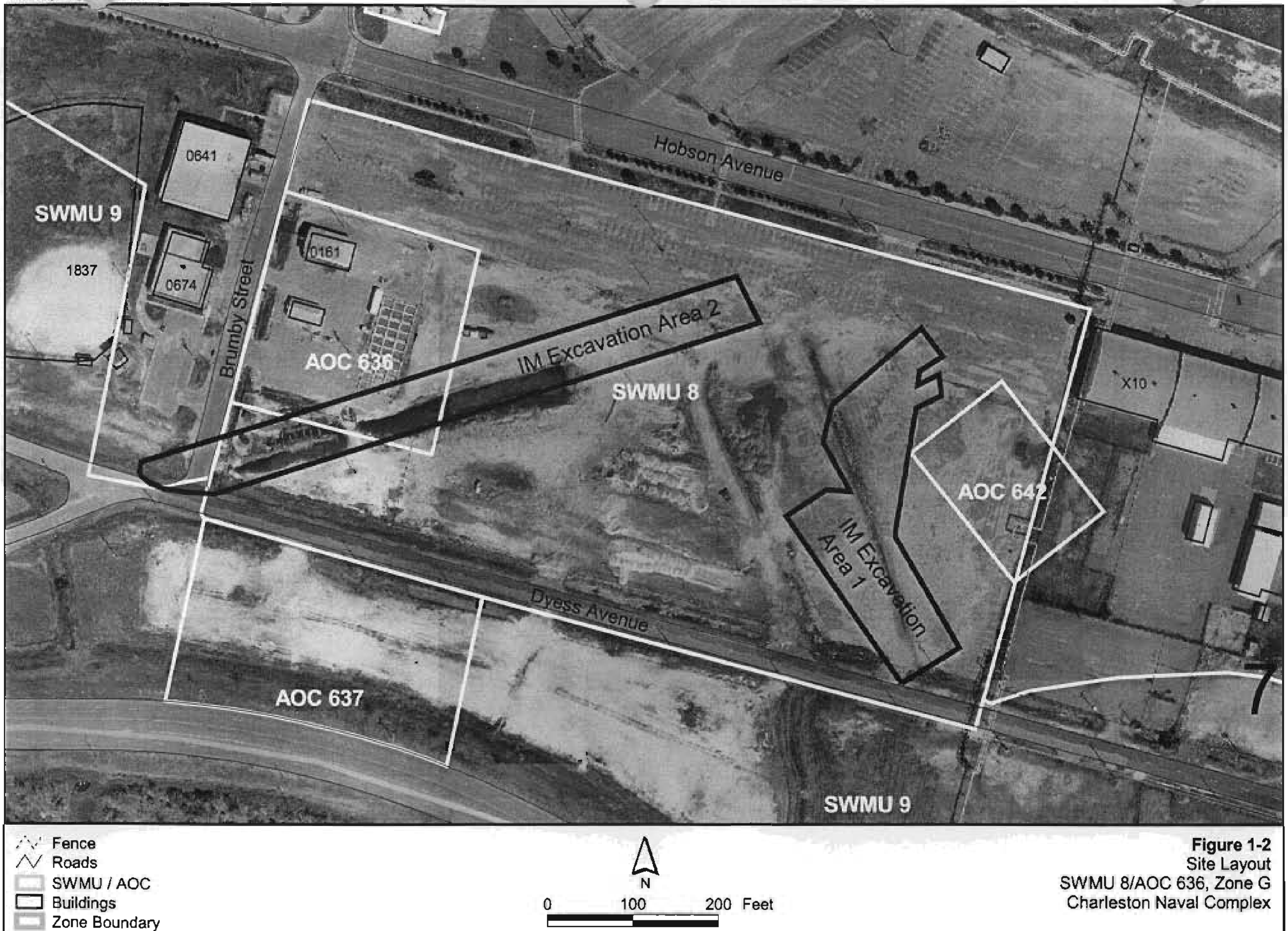
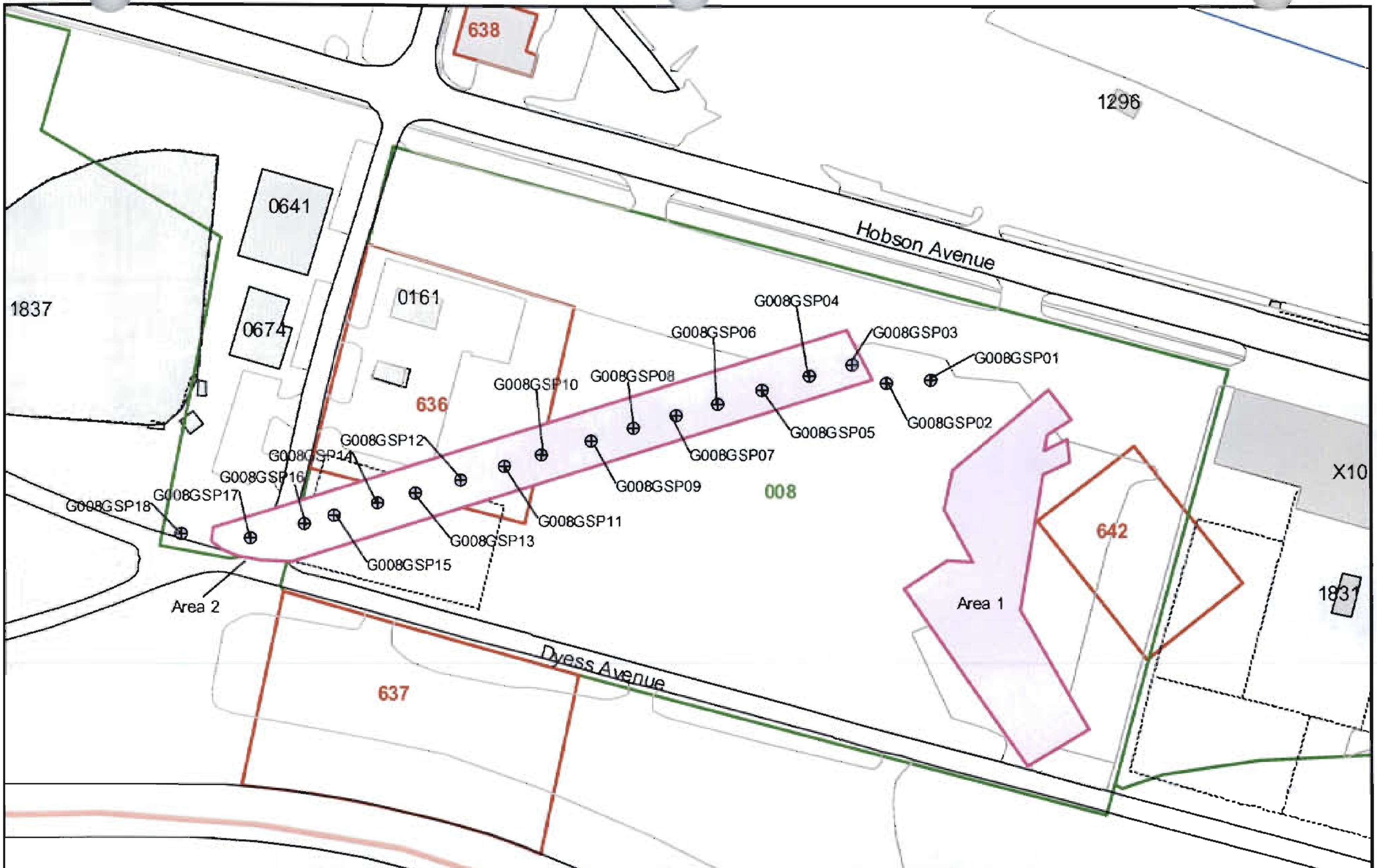


Figure 1-2
Site Layout
SWMU 8/AOC 636, Zone G
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_G\zoneg_locationfig.apr, Date: 26 Sep 2002 11:50, User: NMOUDRY, SWMU 8Figure 1-2 Site Layout

NOTE: Original fig[illegible] in color



Groundwater Sumps
IM Excavation Areas
Fence
Roads
Pavement
Shoreline
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

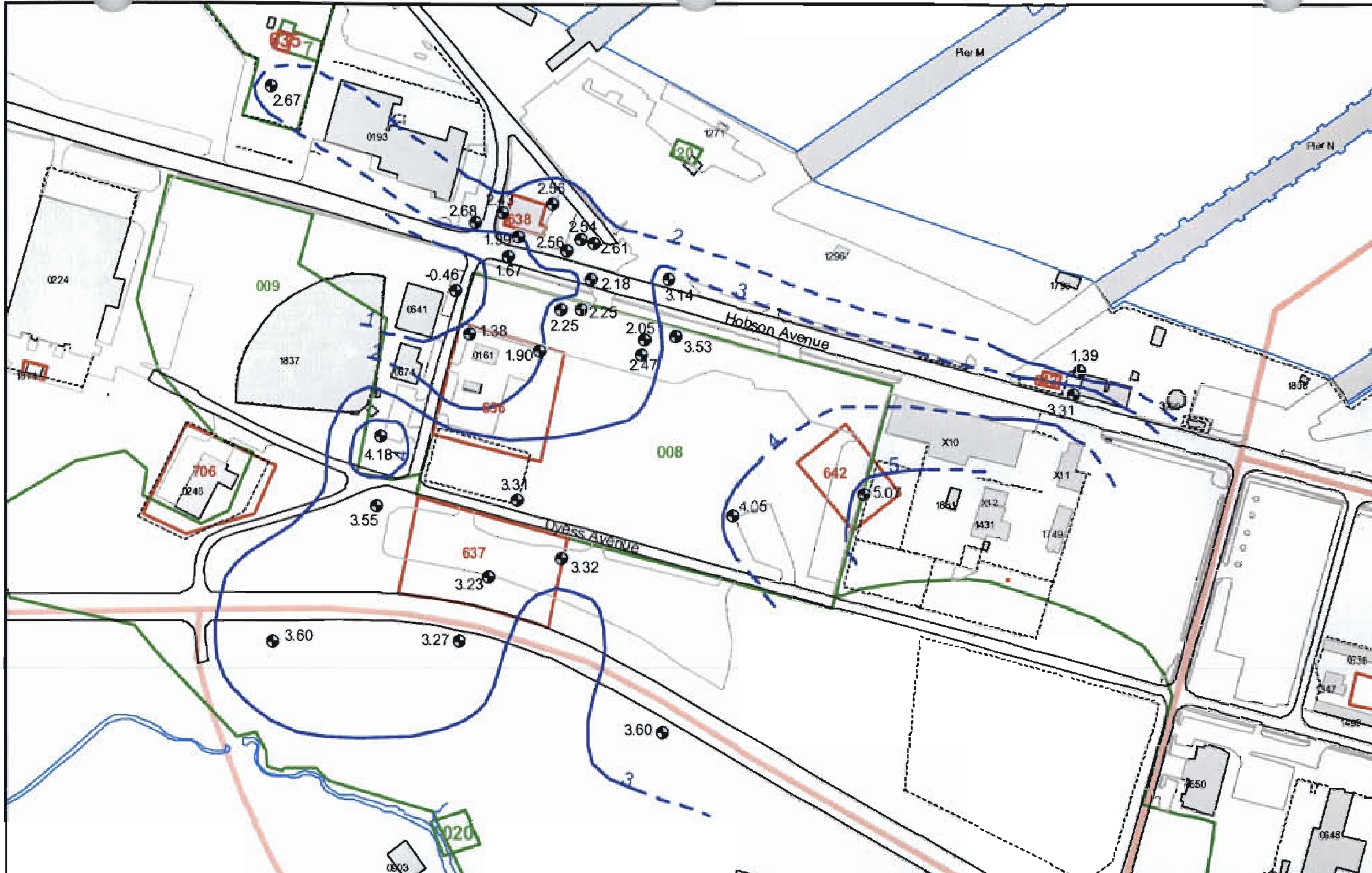
200 0 200 Feet

1 inch = 150 feet

Figure 1-3
Interim Measures Results
Soil Excavation Areas and Groundwater Sump Locations
SWMU 8/AOC 636, Zone G
Charleston Naval Complex

CH2MHILL

File Path: C:\18gis\Projects\Zone_G\swmu8\swmu8.apr, Date: 22 Apr 2003 11:57, User: NMOUDRY, Figure 1-3 Interim Measures Results Soil Excavation Areas and Groundwater Sump Locations



Monitoring Well 3.53 (ft MSL)
Known Groundwater Contour (ft MSL)
Inferred Groundwater Contour (ft MSL)
Fence
Shoreline
Roads
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 300 600 Feet

1 inch = 300 feet

Figure 1-4
Shallow Groundwater Potentiometric Surface
SWMU 8/AOC 636, Zone G
Charleston Naval Complex

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File Path: C:\18g.s\Projects\Zone_G\swmu8\swmu8.apr, Date 22 Apr 2003 11:58, User: NMOUDRY, Figure 1-4 Shallow Groundwater Potentiometric Surface

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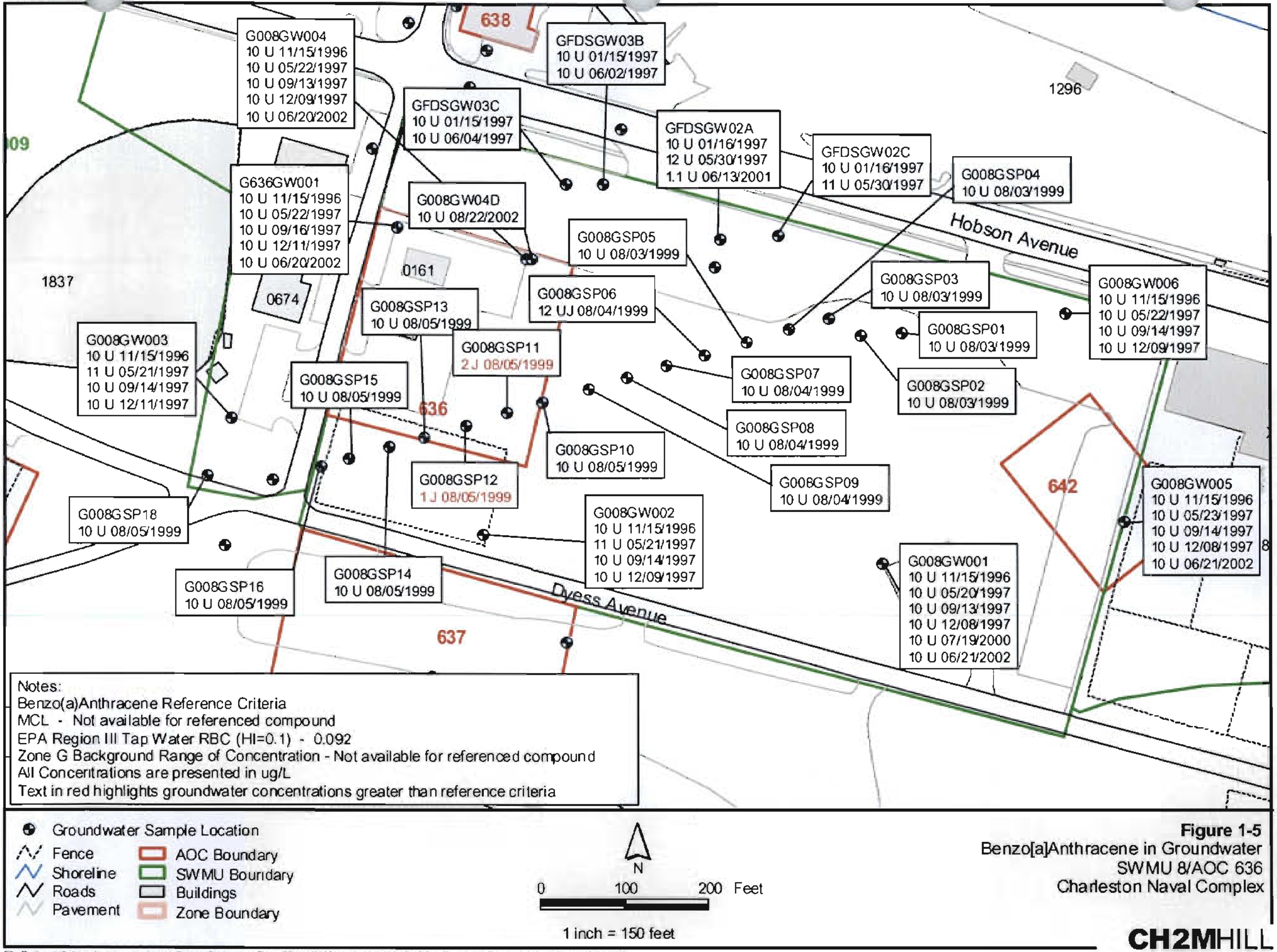
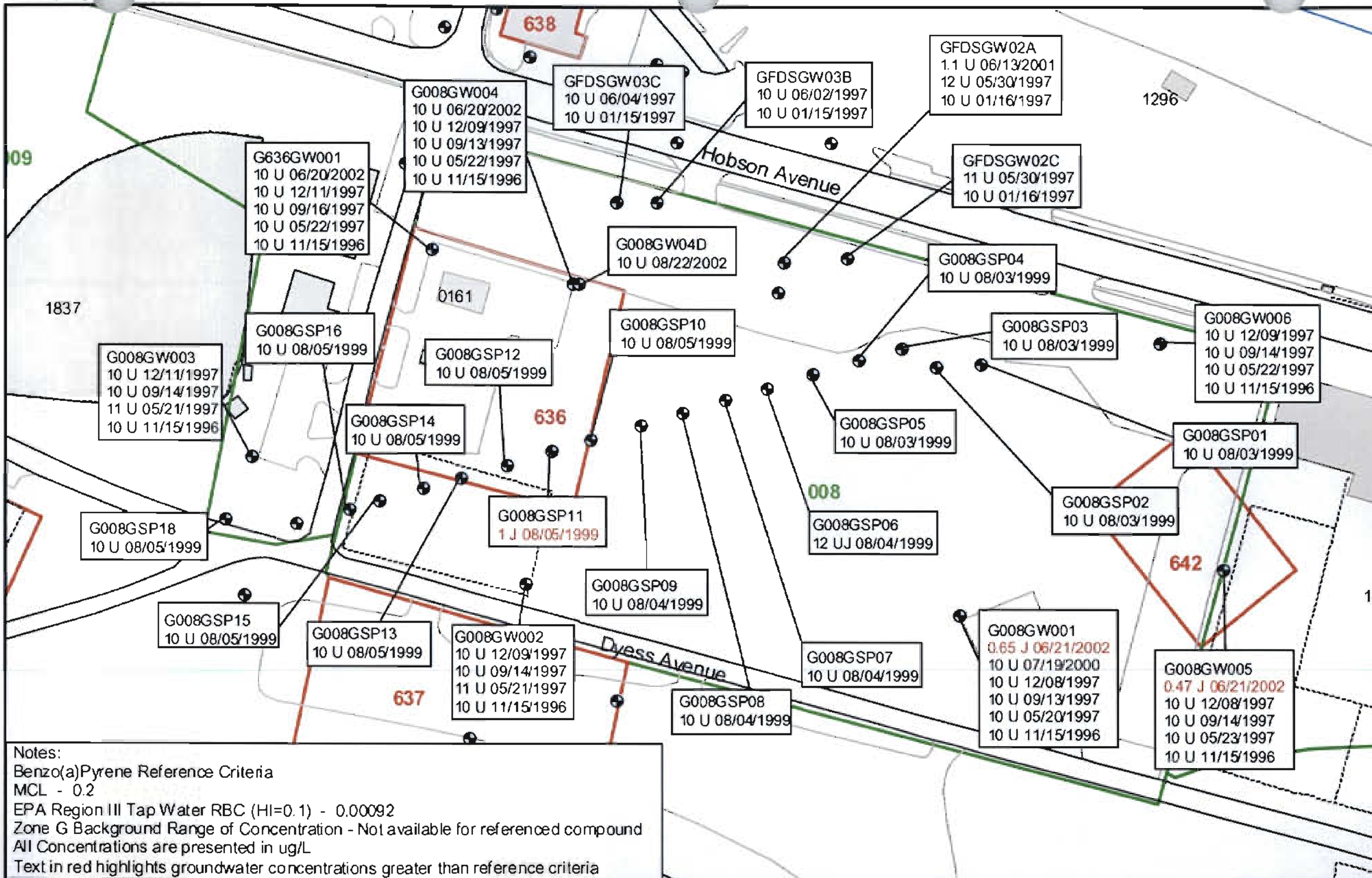


Figure 1-5
Benzo[a]Anthracene in Groundwater
SWMU 8/AOC 636
Charleston Naval Complex

File Path: c:\18gis\projects\zone_g\swmu8swmu8_cms.apr, Date: 22 Apr 2003 11:47, User: NMOUDRY, Figure 1-5 Benzo(a)Anthracene in Groundwater

NOTE: Original figure in color



Notes:
Benzo(a)Pyrene Reference Criteria
MCL - 0.2
EPA Region III Tap Water RBC (HI=0.1) - 0.00092
Zone G Background Range of Concentration - Not available for referenced compound
All Concentrations are presented in ug/L
Text in red highlights groundwater concentrations greater than reference criteria

Groundwater Sample Location
Fence
Shoreline
Roads
Pavement
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 100 200 Feet

1 inch = 150 feet

Figure 1-6
Benzo[a]Pyrene In Groundwater
SWMU 8/AOC 636
Charleston Naval Complex

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File Path: c:\16gis\projects\zone_g\swmu8\swmu8_cms.apr, Date: 22 Apr 2003 11:48, User NMOUDRY, Figure 1-6 Benzo(a)Pyrene In Groundwater

NOTE: Original figure in color

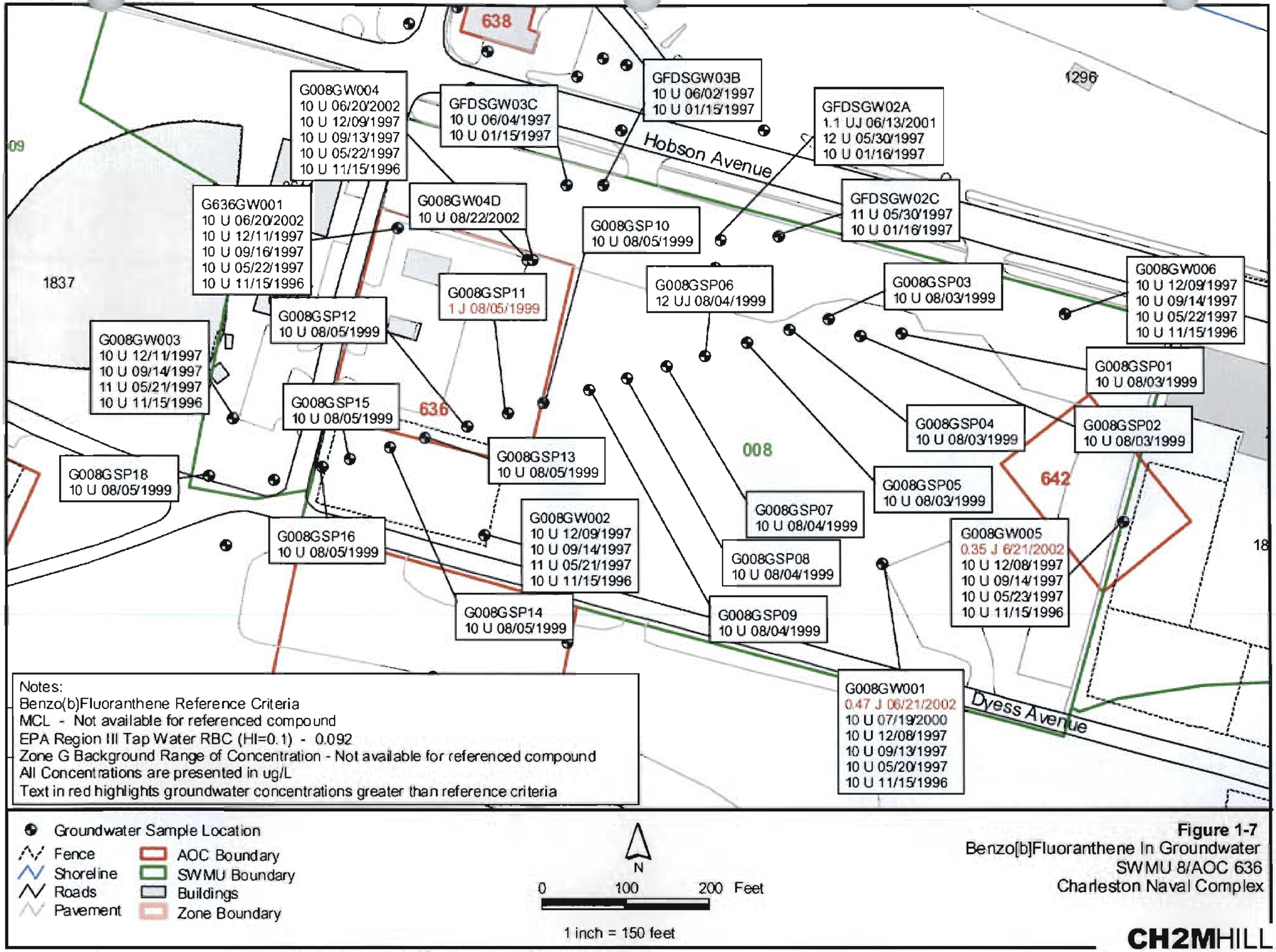

Figure 1-7
Benzo[b]Fluoranthene In Groundwater
SWMU 8/AOC 636
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\projects\zone_g\swmu8swmu8_cms.apr, Date: 22 Apr 2003 11:51, User: NMOUDRY, Figure 1-7 Benzo(b)Fluoranthene In Groundwater

NOTE: Original figure in color

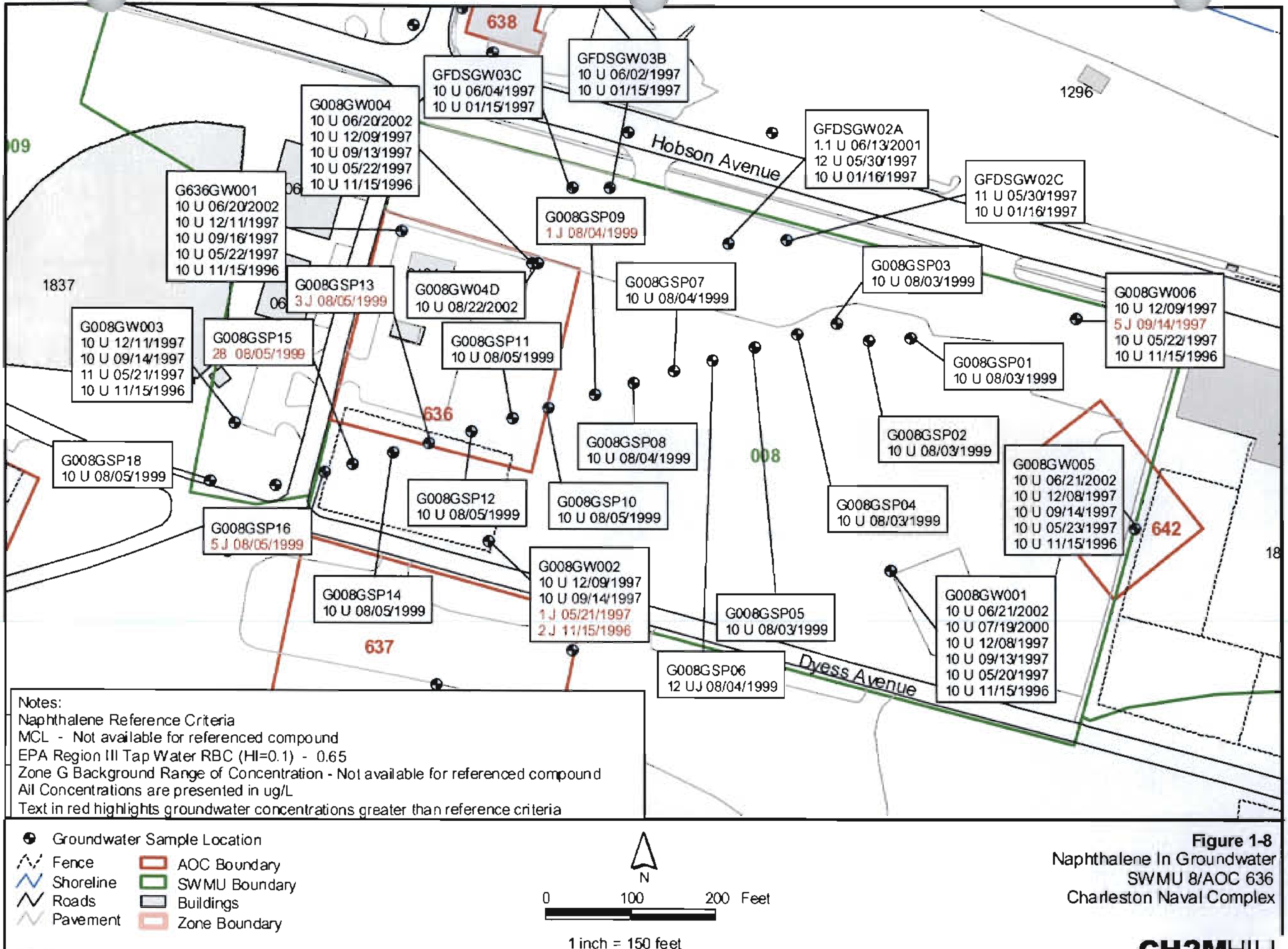

Figure 1-8
Naphthalene In Groundwater
SWMU 8/AOC 636
Charleston Naval Complex

CH2MHILL

File Path: c:\18gis\projects\zone_g\swmu8\swmu8_cms.apr, Date: 22 Apr 2003 11:52, User: NMOUDRY, Figure 1-8 Naphthalene In Groundwater

NOTE: Original figu... in color

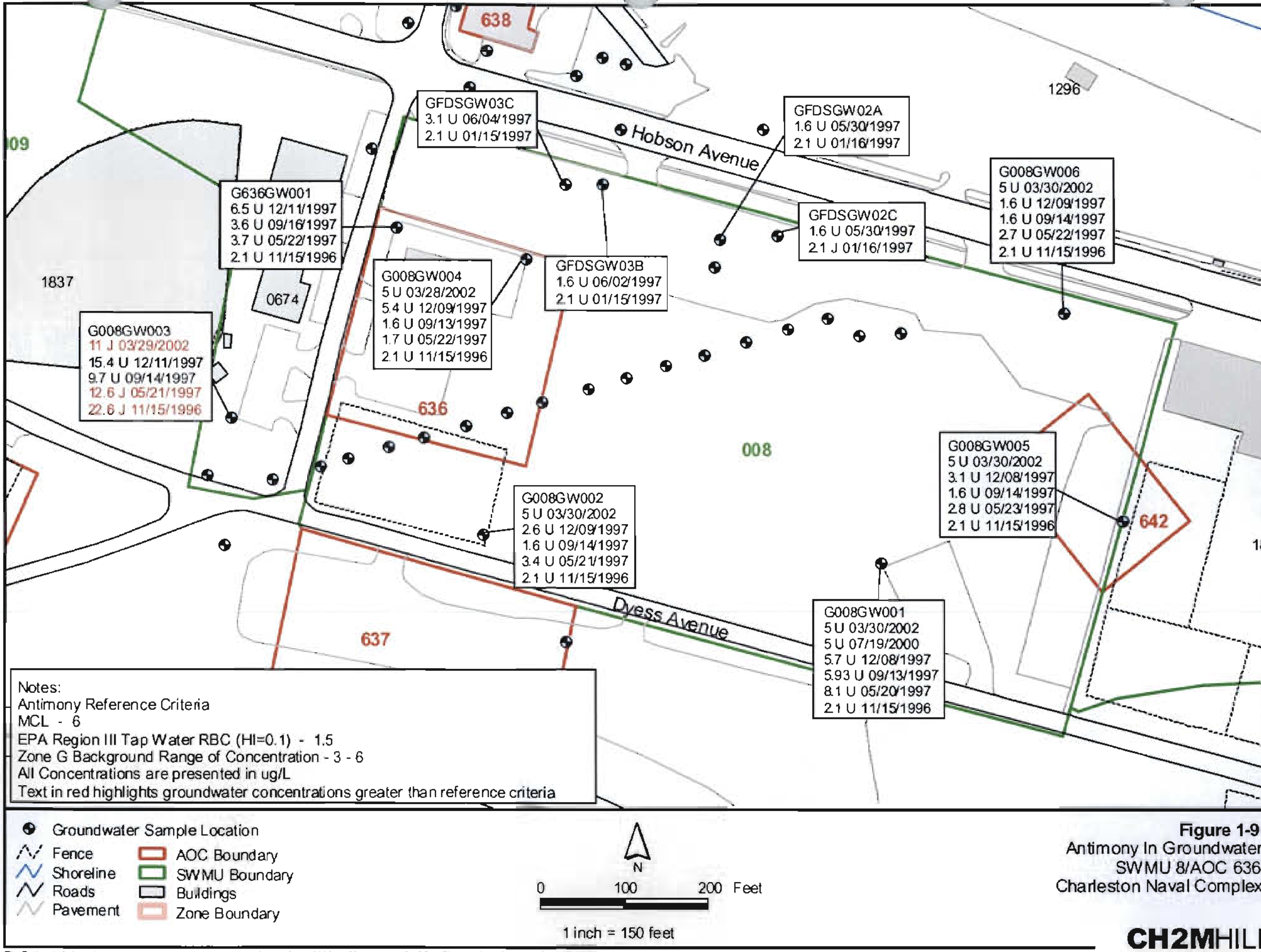

Figure 1-9
Antimony In Groundwater
SWMU 8/AOC 636
Charleston Naval Complex

File Path: c:\18gis\projects\zone_g\swmu8\swmu8_cms.apr, Date: 22 Apr 2003 11:53, User: NMOUDRY, Figure 1-9 Antimony In Groundwater

NOTE: Original figure in color

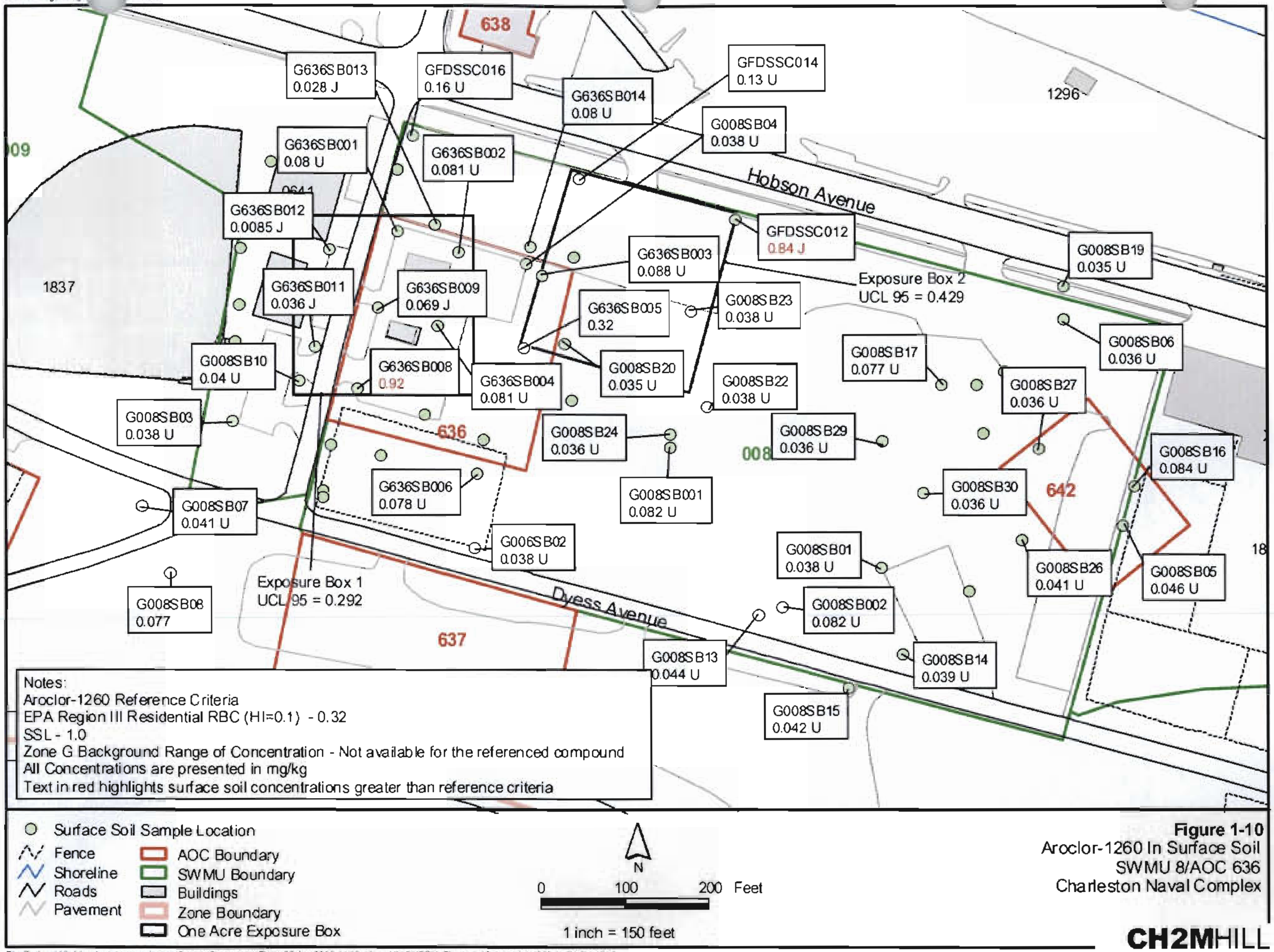

Figure 1-10
Aroclor-1260 In Surface Soil
SWMU 8/AOC 636
Charleston Naval Complex

File Path: c:\18gis\projects\zone_g\swmu8swmu8_cms.apr, Date: 22 Apr 2003 11:53, User: NMOUDRY, Figure 1-10 Aroclor-1260 In Surface Soil

NOTE: Original figure in color

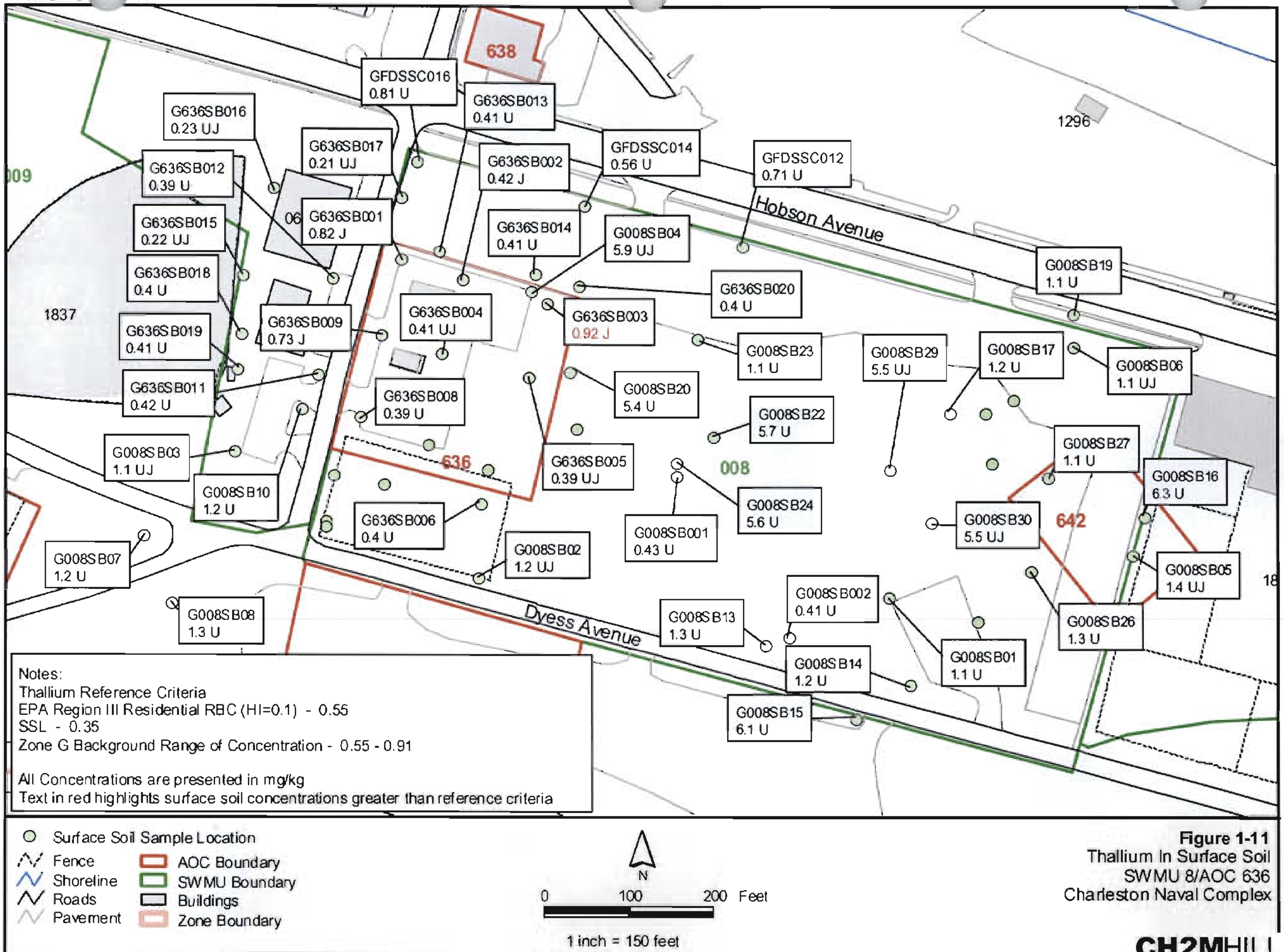

Figure 1-11
Thallium In Surface Soil
SWMU 8/AOC 636
Charleston Naval Complex

File Path: c:\18gis\projects\zone_g\swmu8\swmu8_cms.apr, Date: 22 Apr 2003 11:54, User: NMOUDRY, Figure 1-11 Thallium In Surface Soil

NOTE: Original figu[illegible] in color

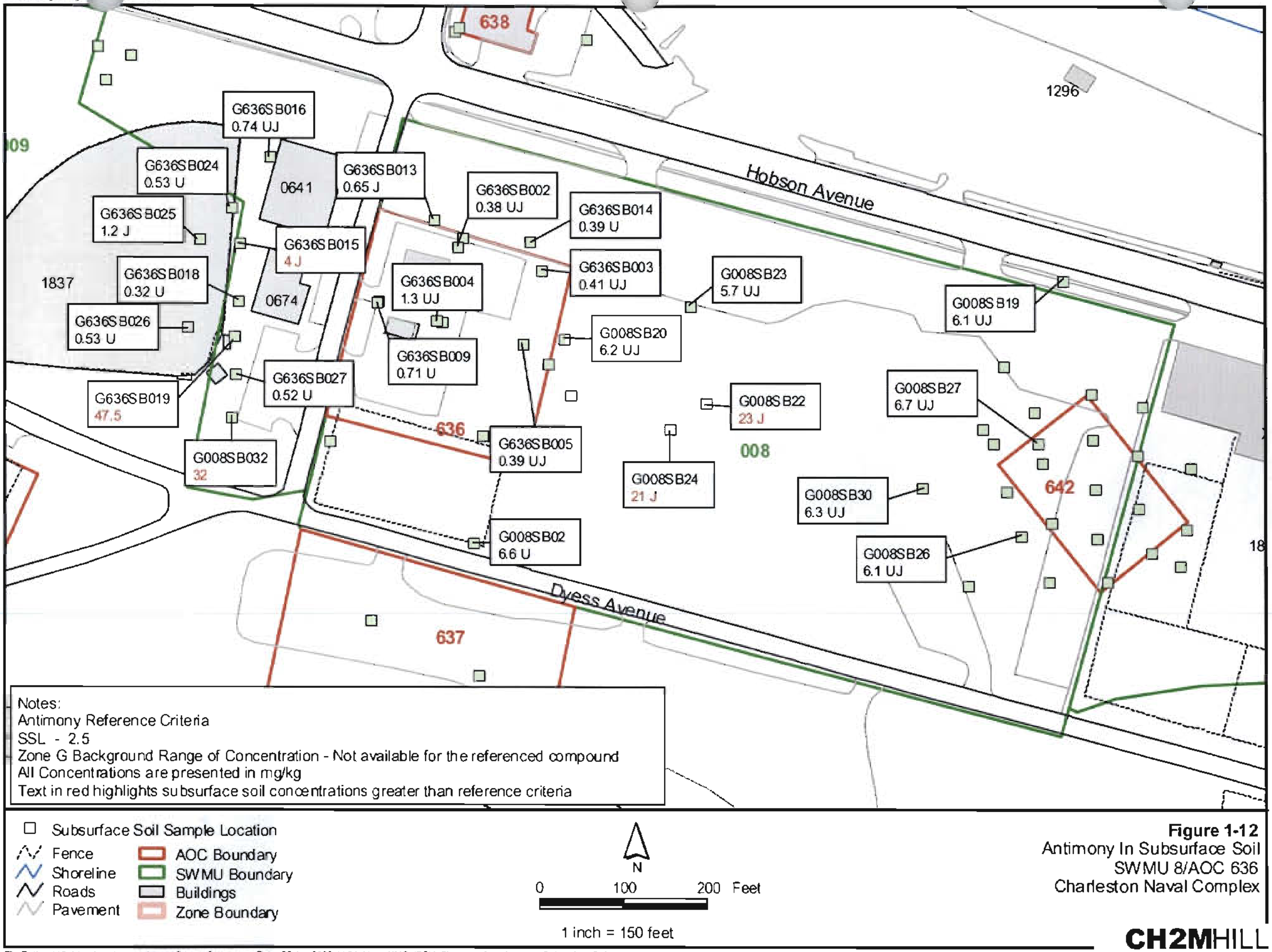

Figure 1-12
Antimony In Subsurface Soil
SWMU 8/AOC 636
Charleston Naval Complex

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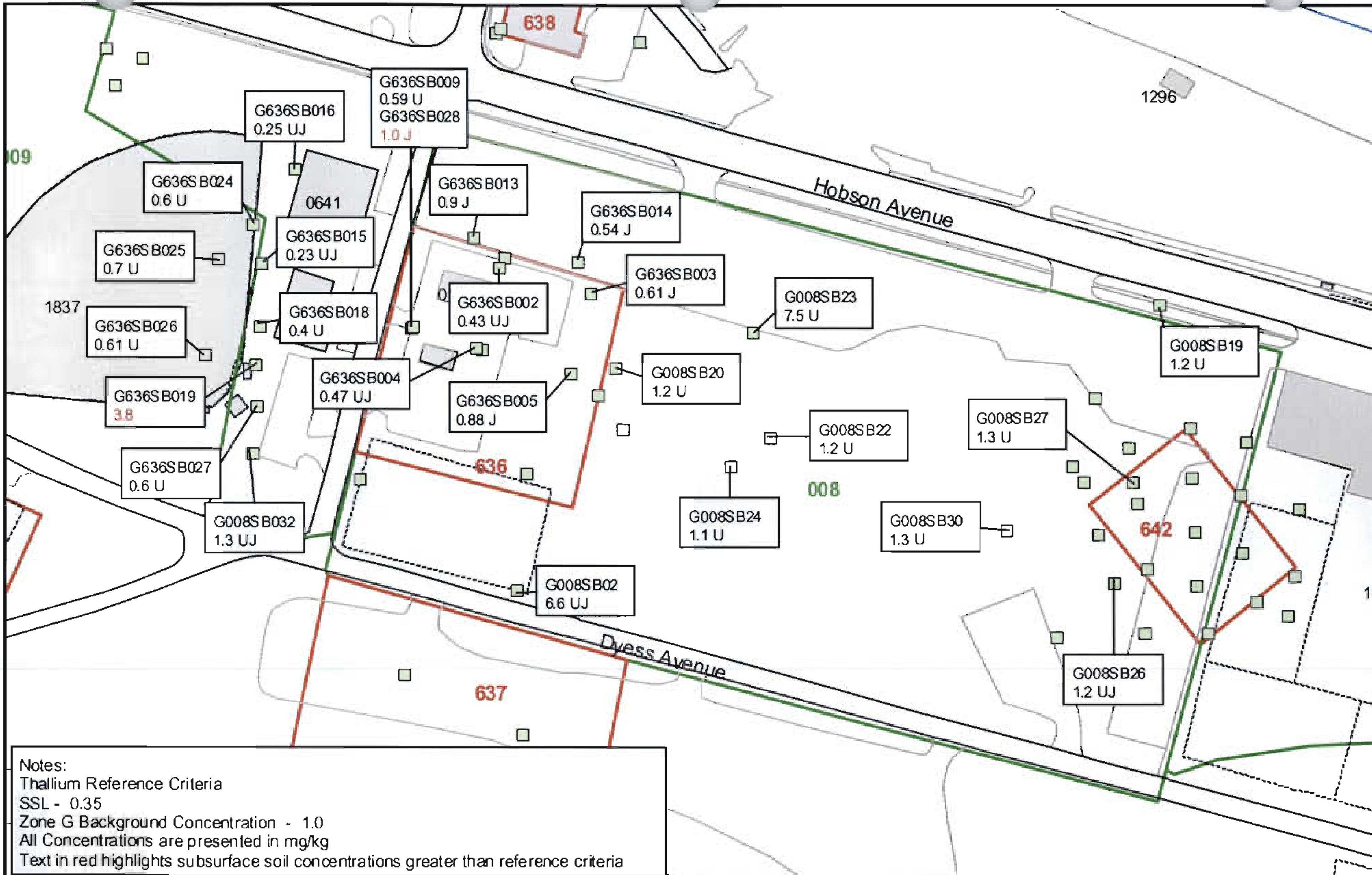
File Path: c:\18gis\projects\zone_g\swmu8\swmu8_cms.apr, Date: 22 Apr 2003 11:54, User: NMOUDRY, Figure 1-12 Antimony In Subsurface Soil

NOTE: Original figu in color



Subsurface Soil Sample Location
Fence
Shoreline
Roads
Pavement
AOC Boundary
SWMU Boundary
Buildings
Zone Boundary

N

0 100 200 Feet

1 inch = 150 feet

Figure 1-13
Thallium In Subsurface Soil
SWMU 8/AOC 636
Charleston Naval Complex

CH2MHILL

Section 2.0

2.0 Remedial Goal Options and Proposed Media Cleanup Standards

RGOs and MCSs are typically developed at the end of the risk assessment in the RFI. RGOs can be based on a variety of criteria, such as drinking water MCLs, specific incremental lifetime cancer risk (ILCR) target levels (e.g., 1E-04, 1E-05, or 1E-06), target HI levels (e.g., 0.1, 1.0, 3.0), or site background concentrations. When area background concentrations are higher than the health protection-based concentrations, the background levels are the target MCSs. Achieving these goals should protect human health and the environment, while achieving compliance with applicable state and federal standards.

2.1 Remedial Action Objectives

RAOs are medium-specific goals that protect human health and the environment by preventing or reducing exposures under current and future land use conditions. In the RFIRA/CMSWP for SWMU 8/AOC 636 (CH2M-Jones, 2003), the RAO for soil, groundwater, and LNAPL is to prevent ingestion and direct/dermal contact with media containing COCs at unacceptable levels.

2.2 Media Cleanup Standards

2.2.1 LNAPL

A proposed MCS for LNAPL was presented in the RFIRA/CMSWP. SCDHEC RCRA regulations and guidance documents do not provide a standard for the removal of LNAPL. Technical standards and corrective action requirements for owners and operators of underground storage tanks (USTs) as outlined in Chapter 61-92, Part 280 under the SCDHEC Bureau of Land and Waste Management, UST Program, addresses the removal of free product (Code of Regulation 61-92, Section 280.64). The regulation states that "*At sites where investigations under Section 280.62(a)(6) indicate the presence of free product, owners and operators must remove free product to the maximum extent practicable as determined by the Department…*". For sites undergoing remediation as part of the SCDHEC UST program, LNAPL removal at UST sites to no more than 0.01 feet (i.e., 1/8 -inch) is typically required by SCDHEC during the remediation phase. This target performance objective is typically documented in the site-specific remediation plan prepared and submitted to the UST program. On this basis, the MCS proposed for LNAPL removal at SWMU 8/AOC 636 is to a measurable thickness of less than or equal to 0.01 feet in the groundwater sumps.

2.2.2 Groundwater COCs

Specific chemicals for which groundwater MCSs are needed include benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, naphthalene, and antimony. The proposed MCSs for benzo[a]anthracene, benzo[b]fluoranthene, and naphthalene are the current EPA Region III tap water RBCs. The proposed MCSs for benzo[a]pyrene and antimony are the drinking water MCLs. These values are presented in Table 2-1.

2.2.3 Surface Soil COCs

MCSs are required for the surface soil COCs Aroclor-1260 and thallium. The proposed MCS for Aroclor-1260 is the EPA Region III residential RBC (0.32 mg/kg.) The proposed MCS for thallium is the background concentration (based on Zone G grid surface soil samples). The surface soil MCSs are presented in Table 2-1.

2.2.4 Subsurface Soil COCs

MCSs are required for subsurface soil COCs thallium and antimony. The proposed MCS for antimony in subsurface soil is the background concentration (based on Zone H grid subsurface soil samples). A Zone G background concentration was not established for antimony in subsurface soil. However, because of its close proximity to Zone G and the SWMU 8/AOC 636 site, the Zone H background concentration was selected as the MCS. The proposed MCS for thallium in subsurface soil is the background concentration, based on Zone G grid subsurface soil samples. The subsurface soil MCSs are presented in Table 2-1.

MCSs for metals in surface and subsurface soil will be met if the site statistical estimates of concentrations are similar to background statistical estimates. For point comparisons between site and background, concentration ranges of the site may be compared with the ranges of background concentrations. Other potential RGOs, such as the EPA Office of Solid Waste and Emergency Response (OSWER) SSLs for subsurface soil or the EPA Region III residential RBC (HI=0.1) for thallium in surface soil, were considered but regarded as not applicable because the site background concentrations of these metals are greater than these levels.

TABLE 2-1
MCSs for LNAPL, Groundwater, and Soil at SWMU 8/AOC 636
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/Chemical	MCS	Criteria
LNAPL	0.01 feet	SCDHEC UST Program
Groundwater (µg/L)		
Benzo[a]anthracene	0.092	EPA Region III Tap Water RBC (HI=0.1)
Benzo[a]pyrene	0.2	MCL
Benzo[b]fluoranthene	0.092	EPA Region III Tap Water RBC (HI=0.1)
Naphthalene	0.65	EPA Region III Tap Water RBC (HI=0.1)
Antimony	6	MCL
Surface Soil (mg/kg)		
Aroclor-1260	0.32	EPA Region III Residential RBC (HI=0.1)
Thallium	Zone G Background Concentration	Meet Background concentration on statistical basis
Subsurface Soil (mg/kg)		
Antimony	Zone H Background Concentration	Meet Background concentration on statistical basis
Thallium	Zone G Background Concentration	Meet Background concentration on statistical basis

HI Hazard Index

MCL Maximum contaminant level

µg/L Micrograms per liter

mg/kg Milligrams per kilogram

Section 3.0

3.0 Overall Approach for Evaluating Focused Alternatives for SWMU 8/AOC 636

3.1 Preferred Remedies

A variety of corrective measure approaches are conceptually feasible for addressing the contaminated media at SWMU 8/AOC 636. For sites where contamination is relatively limited in extent, remedy selection at the CNC has focused on a few technologies that have been demonstrated to be effective for similar contaminants under similar site conditions.

3.1.1 LNAPL Recovery

The goal of the LNAPL recovery is to meet the MCS of no greater than 0.01 ft of measurable LNAPL in the wells. Removal of the LNAPL will remove the source of PAH groundwater contamination. Potential approaches to LNAPL recovery include periodic manual removal (by field personnel using pumps and well purging equipment), various mechanical LNAPL removal systems, and passive removal methods (such as adsorbent pads). Mechanical devices such as skimmers or pneumatic pumps would be more applicable to well locations such as groundwater sump G008GSP04 where the measured LNAPL thickness has exceeded 1 foot. Manual LNAPL recovery may be a suitable method for both sumps.

Some of the technologies may be combined or used in succession to achieve complete LNAPL recovery. For example, it may be practicable to initiate manual LNAPL recovery at well G008GS004, and then determine after several months whether installing a mechanical recovery system is warranted.

In this focused CMS, candidate LNAPL recovery alternatives are described and preliminarily screened in Section 4.0. Viable alternatives based on preliminarily screening (i.e., effectiveness, implementability, and cost) are evaluated in detail in Section 5.0 using the criteria presented in Section 3.2. Recommended alternatives are presented in Section 6.0.

3.1.2 PAHs in Groundwater

PAHs were only infrequently detected in groundwater at the site, most frequently in groundwater samples collected from the sumps installed within the former oil pit areas. The areal extent of the PAH detections in groundwater is generally limited. The removal of residual LNAPL will result in the elimination of the residual source of PAHs in groundwater. Low levels of remaining PAHs are not expected to migrate significantly from the site. The lack of significant migration of PAHs during many previous years, during which significant amounts of LNAPL were present at the site, confirms that the migration potential of PAHs in groundwater at this site is minimal. PAHs will slowly degrade in the environment. For these reasons, the preferred remedy for PAH contaminated groundwater is monitoring/natural attenuation (MNA), in conjunction with the removal of residual LNAPL.

For antimony in groundwater, long-term groundwater monitoring (with filtration if turbidity is found to exceed 10 Nephelometric Turbidity Units [NTUs] at well G008GW003) is recommended as the preferred remedy. This is the only well in which antimony concentrations were found to exceed the MCL, and the exceedances were intermittent.

3.1.3 Soil Contaminants

For contaminants in soil that are limited in areal extent and occur at sites located within an industrial/commercial type setting, preferred technologies include excavation and offsite disposal (dig and haul) and land use controls (LUCs). Generally, at sites zoned for industrial use at which COCs have been identified for the unrestricted land use scenario, a preference exists for implementing LUCs. For this reason, LUCs are selected as the preferred remedy for Aroclor-1260 in surface soil. Aroclor-1260 was identified as a COC only for the unrestricted land use scenario and SWMU 8 is zoned for industrial land use.

Thallium was identified as a COC in surface and subsurface soil due to several soil samples that exceeded the SSL for thallium. However, thallium detections in groundwater at concentrations above its MCL were intermittent and thallium was not considered a groundwater COC. LUCs are recommended with periodic (e.g., every 2 to 5 years) groundwater monitoring of selected wells to confirm that thallium is not leaching into groundwater at concentrations that present an unacceptable risk. If thallium continues to be undetected in groundwater (i.e., it is not leaching from soil), it can be eliminated as a soil COC.

Antimony was identified as a subsurface soil COC due to several exceedances of its SSL. These exceedances occurred in the southwest portion of SWMU 8 near its westernmost boundary. Well G008GW003, located in the vicinity of these subsurface soil exceedances is the only well at SWMU 8 with elevated antimony concentrations intermittently detected in groundwater. Thus the subsurface soil in this area could be a source of the antimony exceedances in groundwater. Several alternatives will be evaluated for antimony in subsurface soil, including soil excavation and LUCs combined with long-term groundwater monitoring.

3.2 Evaluation Criteria

According to the RCRA permit issued by SCDHEC (SCDHEC, 1998), the alternatives are to be evaluated with the following five criteria:

1. Protect human health and the environment.
2. Attain MCSs, which will generally be the RGOs.
3. Control the source of releases to minimize future releases that may pose a threat to human health and the environment.
4. Comply with applicable standards for the management of wastes generated by remedial activities.
5. Other factors include a) long-term reliability and effectiveness; b) reduction in toxicity, mobility, or volume of wastes; c) short-term effectiveness; d) implementability; and e) cost.

Each of the five criteria is defined in more detail below:

3.2.1 Protect Human Health and the Environment

The alternatives were evaluated on the basis of their ability to protect human health and the environment. The ability of an alternative to achieve this criterion may or may not be independent of its ability to achieve the other standards. For example, an alternative may be protective of human health, but may not be able to attain the MCSs if the MCSs are not directly tied to protecting human health.

3.2.2 Attain MCSs

The alternatives were evaluated on the basis of their ability to achieve the RGOs defined in the RFIRA/CMSWP (CH2M-Jones, 2003). Another aspect of this criterion is the time frame to achieve the RGOs.

3.2.3 Control the Source of Releases

This standard deals with the control of releases of contamination from the source (the area in which the contamination originated).

3.2.4 Comply with Applicable Standards for Management of Wastes

This criterion deals with the management of wastes derived from implementing the alternatives; for example, treatment or disposal of well cuttings, contaminated groundwater, or excavated material from a source area.

3.2.5 Other Factors

Five other factors are to be considered if an alternative is found to meet the four criteria described above. These other factors are as follows:

Long-term Reliability and Effectiveness

The various alternatives will be evaluated on the basis of their reliability, and the potential impact should the alternative fail. In other words, a qualitative assessment was made as to the chance of the alternatives failing and the consequences of that failure.

Reduction in the Toxicity, Mobility, or Volume of Wastes

Alternatives with technologies that reduce the toxicity, mobility, or volume of the contamination were generally favored over those that do not. Consequently, a qualitative assessment of this factor was performed for each alternative.

Short-term Effectiveness

Alternatives were evaluated on the basis of the risk they create during the implementation of the remedy. Factors that may be considered include fire, explosion, and exposure of workers to hazardous substances.

Implementability

The alternatives were evaluated for their implementability by considering any difficulties associated with conducting the alternatives (such as the construction disturbances they may create), operation of the alternatives, and the availability of equipment and resources to implement the technologies comprising the alternatives.

Cost

A net present value of each alternative was developed. These cost estimates were used for the relative evaluation of the alternatives, not to bid or budget the work. The estimates were based on information available at the time of the CMS and on a conceptual design of the alternative and are "order-of-magnitude" estimates with a generally expected accuracy of -30 percent to +50 percent for the scope of action described for each alternative. The estimates were categorized into capital costs and operation and maintenance (O&M) costs for each alternative.

Section 4.0

4.0 Description of Candidate Corrective Measure Alternatives

This section presents the identification and description of candidate corrective measure alternatives for addressing LNAPL and groundwater and soil COCs at SWMU 8/AOC 636. Candidate alternatives will be selected for evaluation and comparison based on a preliminary screening using the criteria of effectiveness, implementability, and cost.

4.1 LNAPL Recovery Alternatives

4.1.1 Evaluation Approach

Currently available LNAPL recovery technologies were screened for applicability to characteristics of the LNAPL (density and viscosity) and physical conditions present at SWMU 8/AOC 636; with only viable technologies known for effective LNAPL recovery selected for analysis. Analyses of these selected technologies provides the rationale to support the selection of the recommended corrective measure alternatives. A detailed analysis of corrective measure alternatives for LNAPL recovery is provided in Section 5.0.

4.1.2 Description of Alternatives

Active LNAPL Recovery Alternatives

LNAPL thicknesses greater than 1 foot have been measured at groundwater sump G008GSP04. Recent LNAPL recovery completed in April 2003 consisting of a controlled vacuum at the LNAPL interface produced approximately 60 gallons of product during a 3-hour recovery event at this sump. Given the potential quantity of LNAPL that may be recovered from this groundwater sump, passive recovery alternatives such as absorbent pads are not appropriate as an initial remedy. However, a passive remedy could be appropriate after the amount of LNAPL that recharges this well decreases.

Manual LNAPL Recovery

Manual LNAPL recovery would involve periodic (e.g., weekly or biweekly) removal of accumulated LNAPL by a field team, using pumps, bailers, or other equipment. LNAPL would be removed from the wells and stored in a 55-gallon drum or similar container. When full, the container would be hauled to an approved disposal facility. Manual LNAPL recovery is commonly employed in the petroleum industry and could easily be implemented at this site. A fence would be installed around the sump to allow for security and prevent tampering with the system. LNAPL bailed from the well would be stored temporarily within the fenced area until the LNAPL container is full and ready for disposal.

Skimmers or Pneumatic Pumps

Skimming systems rely on pumps (surface mounted or floating) to actively extract LNAPL. The more common forms of skimmers used include floating skimmers, belt skimmers, and pneumatic pumps. Floating skimmers are placed on the water table where a hydrophobic screen or floating screen inlet allows only LNAPL to enter the pump device or bailer. Belt skimmers use a continuous loop of hydrophobic material to remove LNAPL as it is cycled into and out of the well. Pneumatic skimmers may have a top intake that allows skimming of fluids from the free product/water interface, or a density sensitive float valve that limits the quantity of water recovered. Skimmers require electric service and in the case of pneumatic pumps, electric service coupled with an air compressor.

An alternative skimmer-type system used in remote locations is a solar powered LNAPL recovery system. This skimmer is powered by solar panels and a rechargeable battery. Manufacturers literature for an example of this type of skimmer is provided in Appendix A. This specific version is equipped with a double diaphragm pump and 24-gallon storage tank. It is convenient in locations where electrical service can not be provided. For the SWMU 8/AOC 636 site, the preferred skimmer pump alternative is a solar powered unit. This type of system has the advantage of not requiring that electric power or compressed air supply be provided to the sumps, thus resulting in lower installation costs.

LNAPL Vacuum Extraction

Various forms of LNAPL vacuum extraction are available. Simple LNAPL extraction uses a drop tube inserted into the well to the top of the LNAPL surface and a controlled vacuum of less than 10 inches of mercury (in Hg) to recover LNAPL. To assist in controlling the applied vacuum, the well or sump is left open to the atmosphere. This method recovers minimal groundwater when implemented effectively.

An alternate type of vacuum extraction is referred to as aggressive fluid vapor recovery (AFVR). With AFVR, the vacuum connection is sealed to the well head and a vacuum applied to the well. AFVR extracts all available fluids from the well, including LNAPL, soil vapor, and groundwater. Typical applied vacuum ranges from 21 to 25 in Hg.

For the SWMU 8/AOC 636 site, the preferred method of vacuum extraction would be simple vacuum extraction.

Passive LNAPL Recovery Alternatives

Passive LNAPL alternatives may be used immediately at sump G008GSP11, where only 0.01 ft of LNAPL were observed during the most recent inspection, and may be used at G008GSP04 when active LNAPL recovery alternative is no longer effective or economically viable based on LNAPL thickness.

Butane Biosparging™

This technology involves the delivery of compressed air mixed with butane to the saturated zone near the LNAPL/groundwater interface. It is viable LNAPL removal technology when the measured thickness is less than a few inches. The air/butane delivery system injects low volumes of butane gas at a predetermined rate into the air stream from an air compressor. The butane/air mixture is distributed into the groundwater via injection wells. The butane dissolves into the groundwater and provides a food source for butane and petroleum degrading bacteria; and with increased dissolved oxygen (DO), the butane stimulates an increase in biomass and treatment by direct metabolism of hydrocarbons and cometabolism of more recalcitrant compounds. The Butane Biosparging™ alternative requires both electrical service and an air compressor.

Absorbent Pads

Absorbent pads are specially designed pads placed in the well across the surface of the LNAPL to absorb LNAPL. Once the material has absorbed its LNAPL capacity, it is replaced and properly disposed of. This method of LNAPL recovery is one of the least labor intensively technologies and widely used in the petroleum industry.

4.1.3 Preliminary Screening of LNAPL Recovery Alternatives

Candidate active and passive LNAPL recovery alternatives were screened using effectiveness, implementability, and cost as screening criteria. A summary of the preliminary screening is provided in Table 4-1. The results and conclusions made based on the preliminary screening are provided in Section 4.1.4, with selected alternatives further evaluated using the criteria outlined in Section 3.2.

4.1.4 Preliminary Screening Conclusions

Based on the preliminary screening, active, and passive LNAPL alternatives retained include manual LNAPL recovery, a solar powered skimmer, and absorbent filters. These corrective measure alternatives are evaluated in Section 5.0 of this report using the evaluation criteria outlined in Section 3.2.

Manual recovery methods were retained because they are easily deployable, economical, and commonly used. The solar powered unit provides for continuous operation without the need for providing electrical service to the sumps, is easily installed, and requires little operations and maintenance (O&M) effort.

Absorbent pads were retained as a passive alternative since they can be easily installed, are effective, and require little to no maintenance.

Active recovery methods using non-solar powered skimmers and similar devices were not retained since they would require that electrical service and possibly compressed air be delivered to the sumps and the devices offered no significant advantages over other available methods. The Butane Biosparging™ alternative was not considered for further evaluation because it is expensive and relatively difficult to implement compared to bailing and absorbent filters. The technology, better suited for a large LNAPL recovery area, requires injection well installation, electrical service, a skid-mounted treatment system, and an extensive O&M schedule.

4.2 Groundwater Alternatives

4.2.1 Monitored Natural Attenuation

Natural attenuation is the reduction of contaminant concentration by the natural processes present in the aquifer, including volatilization, hydrolysis, dilution, dispersion, adsorption, and biotic and abiotic degradation. The collective effect of these processes is termed natural attenuation. MNA is a careful evaluation of natural attenuation mechanisms using monitoring.

Natural attenuation was recommended as the presumptive remedy for PAHs in groundwater because: 1) detected PAHs have occurred on a limited basis at low concentrations at the site, largely in the sumps installed in the former oil pits, 2) the PAHs are not migrating in groundwater, and 3) the LNAPL recovery will remove the residual source of the PAHs.

EPA has issued a Draft Final OSWER Directive on Monitored Natural Attenuation (EPA, 1997), in which it recognizes that MNA is appropriate as a remedial approach, "where it can be demonstrated capable of achieving a site's remedial objectives within a time frame that is reasonable compared to that offered by other methods, and where it meets the applicable remedy selection criteria for that particular OSWER program." EPA clearly states its expectation that "monitored natural attenuation will be most appropriate when used in conjunction with active remediation measures (e.g., source control) or as a follow-up to active remediation measures that already have been implemented."

Under the natural attenuation alternative, the low-level PAH concentrations previously detected in the surficial aquifer would be evaluated using a monitoring system designed to track the plume location and magnitude. Monitoring data would be compared to the predicted transport and fate of the contaminants to check predictions accuracy.

In general, the MNA alternative consists of three major features:

- A designed monitoring program;
- A tracking and data evaluation program; and
- A contingency response plan in the event that the monitoring indicates downgradient migration of dissolved PAHs and/or antimony.

The MNA alternative would be implemented in conjunction with a long-term monitoring plan. The purpose of the plan is to monitor potential contaminant migration over time, and to verify that natural attenuation is occurring. The plan would specify existing wells located within, upgradient to, crossgradient to, within, and downgradient of the known dissolved-phase contaminant concentrations above their screening criteria.

The monitoring plan would include PAHs, metals (at selected locations), and field parameters (DO, oxidation/reduction potential (ORP), pH, turbidity, and temperature). The data would provide characterization of plume extent, groundwater quality, and ORP indicators. It is expected that concentrations of PAHs and antimony will slowly decrease as a result of natural attenuation.

4.3 Soil Alternatives

LUCs or LUCs with monitoring were identified as the preferred alternative for soil impacted by PCBs and thallium. LUCs will include the following administrative controls:

- Restrictions limiting the property land use to non-residential activities.
- Restrictions to maintain the extent of paved area (limited to the area surrounding AOC 636), unless a demonstration is made that changing a currently paved area to unpaved status will not cause one of the RAOs to not be met.

- Periodic (every 2 to 5 years) groundwater monitoring for thallium to confirm that it is not leaching into groundwater. Once this has been confirmed, thallium can be deleted as a soil COC.

4.3.1 Land Use Controls

This alternative involves leaving the contaminated soil in place and instituting administrative/legal controls to restrict future use of the land. The controls would limit land use to activities that present less frequent exposure by sensitive populations to soil and LNAPL and preclude uncontrolled disturbance of the contaminated soil, thus minimizing the potential for human exposure to the contamination. The addition of restrictions on soil disturbance and site occupancy would minimize potential for human exposure that could occur in a residential or industrial setting. LUCs will be required until the site is identified by SCDHEC as requiring NFA.

The controls may be in the form of deed restrictions and/or easements (property interests retained by the Navy during property transfer to ensure protectiveness of the remedy). Periodic monitoring would be required to ensure controls are maintained; periodic site inspections would be required to ensure compliance with the institutional controls. Controls may be layered (multiple controls at the same time) to enhance protectiveness. The Navy is negotiating a comprehensive Land Use Control Implementation Plan (LUCIP) for the CNC.

Currently, the Navy is the property owner and land use at the site and in the immediate area is zoned for future light industrial use. Existing engineering controls include a site fence within a gate guarded access area of CNC maintained by the Charleston International Port. The location and proximity of the site to other industrial properties make residential use highly unlikely. Periodic monitoring of the deed controls and the site would be required. For the purpose of developing a representative cost estimate for this process, an annual evaluation that would include a site inspection is assumed.

4.3.2 Soil Excavation and Offsite Disposal

This commonly applied remedy has been used with success at the CNC. This alternative would be potentially applicable to the antimony in subsurface soil. This remedy has the advantages of being easily implemented and effective. It requires that the extent of impacted soil target for remediation be clearly defined. It is expected that if selected, this remedy can be implemented quickly and effectively.

TABLE 4-1
Preliminary Screening of Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Evaluation Criteria	Effectiveness	Implementability	Cost
Active LNAPL Alternatives			
Manual LNAPL recovery	Effective if conducted at appropriate frequency.	Easy to implement. Requires small field team and standard equipment.	Relatively inexpensive.
Skimmer and Pneumatic Pumps (non-solar powered)	Effective continuous LNAPL recovery.	Moderately easy to implement. Electrical service and compressed air required. Installation is quick and easy. Low maintenance required.	Moderate capital cost. Low to moderate maintenance costs. Low labor costs.
Skimmers or Pneumatic Pumps (Solar Powered Unit)	Effective continuous LNAPL recovery.	Easy implementation. Electrical service is not required. Installation is quick and easy. Maintenance required.	Moderate capital cost. Low maintenance cost.
LNAPL Vacuum Extraction	Non-continuous LNAPL recovery limited to scheduled half day extraction events. A limited quantity of groundwater is also recovered.	Easy implementation. Vacuum truck on site for half day recovery event. No maintenance required.	Medium labor cost for subcontractor and subcontractor oversight.
Passive LNAPL Alternatives			
Butane Biosparging™	Effective LNAPL removal technology when the measured thickness is less than a few inches.	Implementation is difficult when compared to other passive technologies. Implementation consists of system construction including butane, injection well installation, and electrical service.	Very expensive when compared to the other passive alternatives. Excessive construction, material, and operation and maintenance costs.
Absorbent Pads	Effective LNAPL recovery where LNAPL thickness is small.	Easy implementation. Easy deployment and retrieval.	Moderately inexpensive capital cost. Low labor cost.
Groundwater Alternatives			
Monitored Natural Attenuation	Expected to be effective, in conjunction with LNAPL recovery.	Easy implementation. Requires monitoring plan.	Relatively inexpensive.

TABLE 4-1
Preliminary Screening of Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Evaluation Criteria	Effectiveness	Implementability	Cost
Soil Alternatives			
LUCs/Monitoring	Expected to be effective.	Easy implementation. Monitoring plan required.	Relatively inexpensive.
Soil Excavation and removal	Effective.	Easy to implement.	Moderately expensive, depending on size of excavation.

Section 5.0

5.0 Detailed Evaluation of Alternatives

The corrective measure alternatives were evaluated relative to the criteria previously described in Section 3.2. The overall ability of each corrective measure alternative to meet the evaluation criteria is described in this section. In Table 5-1, a comparative evaluation of the degree to which each alternative meets a particular criteria is presented. A cost estimate for each alternative was also developed; the assumptions and unit costs used for these estimates are included in Appendix B.

5.1 Active LNAPL Recovery Alternative: Solar Powered Skimmer Unit

The following assumptions were made for the active LNAPL recovery alternative:

- Active LNAPL recovery is limited to one existing groundwater sump (i.e., G008GSP04), as shown in Figure 1-3. The installation of additional recovery wells is not required.
- A fence will be installed around the groundwater sump and LNAPL recovery unit to protect it from tampering.
- Up to 288 gallons of LNAPL will be recovered each year for three years. After three years, an alternate LNAPL recovery method, such as absorbent pads, will be adequate.

5.1.1 Protect Human Health and the Environment

This alternative is effective at protecting human health and the environment because it safely removes LNAPL from the groundwater.

5.1.2 Attain Media Cleanup Standards

This alternative is expected to eventually achieve the LNAPL MCS.

5.1.3 Control the Source of Releases

There are no ongoing sources of releases at SWMU 8/AOC 636; therefore, this issue is not applicable.

5.1.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. Recovered LNAPL will be sampled and analyzed for waste characterization parameters prior to acceptance from the permitted recycling or disposal facility.

5.1.5 Other Factors

Long-term Reliability and Effectiveness

This alternative is expected to have long-term reliability and effectiveness. LNAPL removal from the aquifer will be permanent.

Reduction in the Toxicity, Mobility, or Volume of Wastes

This alternative reduces LNAPL volume and mobility since the LNAPL is removed from the aquifer and hauled to a permitted disposal facility.

Short-term Effectiveness

This alternative is expected to be effective in the short term, as LNAPL recovery will begin immediately upon implementation. The unit will require period inspections to verify it is operating as designed and to optimize recovery operations.

Implementability

This alternative is easily implemented. Installation of the solar powered skimmer unit is quick and simple. The field implementation of this remedy is estimated to require one to two days, and the benefits will be immediate.

Cost

Appendix B presents the overall cost estimate for implementing this active LNAPL recovery alternative. A scope contingency (20 percent) is added to cover additional LNAPL recovery greater than the estimated volume during the three-year O&M period. In summary, the costs include the following:

- Approximately 900 gallons of LNAPL recovery from groundwater sump G008GSP04 during a three-year unit operation duration.
- Performing waste characterization analysis to verify the recovered LNAPL is considered a non-hazardous waste and a non-regulated material under the Toxic Substances Control Act (TSCA).

- Applying a 20-percent contingency for additional scope that may be required based on LNAPL recovery.

Using the assumptions listed above, the total present value of active LNAPL recovery alternative is $34,000.

5.2 Passive LNAPL Recovery Alternative: Absorbent Pads

The following assumptions were made for the passive LNAPL recovery alternative:

- Passive LNAPL recovery is limited initially to one existing groundwater sump (i.e., G008GSP11) as shown in Figure 1-3. The installation of additional recovery wells is not required. In addition, absorbent pads will be used in groundwater sump G008GSP004 once the LNAPL volume is minimal and active treatment is no longer economically viable.

- A total of 150 LNAPL absorbent pads (equating to approximately 55 gallons of recovered LNAPL) will be used in three years.

5.2.1 Protect Human Health and the Environment

This alternative is effective at protecting human health and the environment because it safely removes LNAPL from the groundwater.

5.2.2 Attain Media Cleanup Standards

This alternative is expected to eventually achieve the LNAPL MCS.

5.2.3 Control the Source of Releases

There are no ongoing sources of releases at SWMU 8/AOC 636; therefore, this issue is not applicable.

5.2.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. Recovered LNAPL will be sampled and analyzed for waste characterization parameters prior to acceptance from the permitted recycling or treatment facility.

5.2.5 Other Factors

Long-term Reliability and Effectiveness

This alternative is expected to have long-term reliability and effectiveness. LNAPL removal from the aquifer site will be permanent.

Reduction in the Toxicity, Mobility, or Volume of Wastes

This alternative reduces LNAPL volume and mobility since the recovered material will be removed from the aquifer and disposed to a permitted disposal facility.

Short-term Effectiveness

This alternative will be effective in the short term. Short-term effectiveness will be immediate once the absorbent pad is installed. Inspections during the first few weeks of installation will be required to evaluate the schedule for pad replacement.

Implementability

This alternative is easily implemented. The absorbent pad is quick and simple to deploy. The field implementation of this remedy is estimated to require only a few hours and the benefits will be immediate.

Cost

Appendix B presents the overall cost estimate for implementing this passive LNAPL recovery alternative. A scope contingency (20 percent) is added to cover additional absorbent filters greater than the estimated number during the three-year O&M period. In summary, the costs include the following:

- Use of 150 LNAPL absorbent filters in two groundwater sumps during a three-year unit operation duration.
- Performing waste characterization analysis to verify the recovered LNAPL is considered a non-hazardous waste and a non-regulated material under TSCA.
- Applying a 20-percent contingency for additional scope that may be required based on the number of absorbent pads used during the anticipated three-year O&M duration.

Using the assumptions listed above, the total present value of passive LNAPL recovery alternative is $13,400.

5.3 Manual LNAPL Recovery

The following assumptions were made for the manual LNAPL recovery alternative:

- Manual LNAPL recovery is limited to one existing groundwater sump (i.e., G008GSP004) as shown on Figure 1-3. The installation of additional recovery wells is not required.
- A field team of two people will remove the LNAPL once every other week using a small pump equipped with a hose and valve that minimizes the amount of water recovered.
- Manual recovery activities will occur for three years. After three years, an alternate LNAPL recovery method, such as absorbent pads, will be adequate.

5.3.1 Protect Human Health and the Environment

This alternative is effective at protecting human health and the environment because it safely removes LNAPL from the groundwater.

5.3.2 Attain Media Cleanup Standards

This alternative is expected to eventually achieve the LNAPL MCS.

5.3.3 Control the Source of Releases

There are no ongoing sources of releases at SWMU 8/AOC 636; therefore, this issue is not applicable.

5.3.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. Recovered LNAPL will be sampled and analyzed for waste characterization parameters prior to acceptance from the permitted recycling or treatment facility.

5.3.5 Other Factors

Long-term Reliability and Effectiveness

This alternative will have long-term reliability and be effective for the site. LNAPL removal from the site will be permanent.

Reduction in the Toxicity, Mobility, or Volume of Wastes

This alternative reduces volume and mobility since the recovered LNAPL will be removed from the aquifer and disposed to a permitted disposal facility.

Short-term Effectiveness

This alternative will be effective in the short term. Short-term effectiveness will be immediate once LNAPL removal operations begin.

Implementability

This alternative is easily implemented. The method is quick and simple to deploy. The field implementation of this remedy is estimated to require only a few hours, and the benefits will be immediate.

Cost

Appendix B presents the overall cost estimate for implementing this LNAPL recovery alternative. A scope contingency (20 percent) is added to cover additional materials or labor greater than the estimated amount during the three-year O&M period. In summary, the costs include the following:

- A field team of two will use conventional purging equipment to implement the work.
- Waste characterization analysis will be performed to verify the recovered LNAPL is considered a non-hazardous waste and a non-regulated material under TSCA.
- A 20-percent contingency will be applied for additional scope that may be required based on the effort required during the anticipated three-year O&M duration.

Using the assumptions listed above, the total present value of passive LNAPL recovery alternative is $30,000.

5.4 Groundwater Alternative: Monitored Natural Attenuation

This alternative would apply to the PAHs and antimony in groundwater. The following assumptions were made for the MNA groundwater alternative:

- MNA will consist of one annual monitoring event for five years.
- Nine existing monitoring wells or groundwater sumps will be sampled to evaluate natural attenuation of PAHs. One existing monitoring well will be sampled to evaluate changes in dissolved antimony concentration.

The MNA alternative consisting of a monitoring plan would be implemented in conjunction with the active and passive LNAPL recovery alternatives and a remedy for soil containing elevated levels of antimony, if necessary. The purpose of the plan is to monitor dissolved concentrations of PAH and antimony over time, and to verify that natural attenuation is occurring. Assuming that the LNAPL source of the contamination is removed, it is expected that the PAH contaminants would slowly decrease in concentration as a result of natural attenuation. Similarly, once a remedy is selected and implemented for the antimony-containing subsurface soil, antimony concentrations in groundwater would be expected to decrease over time. MNA is one of the easiest groundwater alternatives to implement at a contaminant site and also one of the least expensive.

5.4.1 Protect Human Health and the Environment

This alternative is expected to be protective of human health and the environment. LUCs to restrict consumption of shallow groundwater would be implemented until the groundwater concentrations decrease to levels below MCLs or RBCs.

5.4.2 Attain Media Cleanup Standards

This alternative, coupled with LNAPL recovery and a remedy for antimony impacted subsurface soil, is expected to achieve groundwater MCSs.

5.4.3 Control the Source of Releases

The LNAPL and antimony-impacted subsurface soil would be addressed under separate actions.

5.4.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. The MNA alternative is not expected to accumulate significant quantities of waste requiring management. Limited volume of purge water will be accumulated during the annual monitoring event.

5.4.5 Other Factors

Long-term Reliability and Effectiveness

This alternative is expected to be effective and reliable in the long term.

Reduction of Toxicity, Mobility, or Volume of Wastes

This alternative will gradually reduce the dissolved-phase PAHs and antimony to the MCSs through various natural attenuation processes.

Short-Term Effectiveness

This alternative is expected to be effective in the short term for precluding exposure of the PAHs and antimony in groundwater to receptors via implementation of LUCs.

Implementability

This alternative is easily implemented. MNA involves the minimal degree of site activity and is not difficult to implement.

Cost

Appendix B presents the overall cost estimate for implementing the MNA groundwater alternative. A scope contingency (20 percent) is added to cover additional unexpected sampling events and/or analysis during the five-year O&M period. In summary, the costs include the following:

- Annual sampling event with the collection of groundwater samples from 10 existing monitoring wells or sumps. Nine of the well locations will monitor changes in dissolved PAH concentration and one well will be used to monitor changes in antimony concentration.
- Applying 20-percent contingency for additional scope that may be required based on the number of sampling events and/or analysis to be performed during the 5-year O&M duration.

Using the assumptions listed above, the total present value of MNA groundwater alternative is $44,000.

5.5 Soil Alternative: Land Use Controls and Groundwater Monitoring

This alternative would apply to thallium in surface soil and thallium and antimony in subsurface soil. Assumptions for this alternative include the following:

- A basewide LUCIP will be developed for the CNC. The plan will allow for restrictions on the use of land at SWMU 8/AOC 636 and other areas, and the plan will be developed outside the scope of this CMS. The site would be used only for industrial purposes and restrictions on installation of groundwater wells for use as potable water supply would also be imposed.

- Periodic groundwater monitoring (four biannual sampling events) will be performed to assess whether thallium or antimony is leaching into groundwater such that groundwater is impacted in a manner that presents an unacceptable risk to human health or the environment. The monitoring will also include an annual site visit to confirm that site use(s) are consistent with the LUCIP. Groundwater samples would be collected and analyzed periodically from selected wells to ensure that metals (thallium and antimony) are not leaching.

5.5.1 Protect Human Health and the Environment

This alternative is expected to be protective of human health and the environment. LUCs to restrict consumption of shallow groundwater would be implemented until the groundwater concentrations of all COCs are below applicable MCLs or RBCs.

5.5.2 Attain Media Cleanup Standards

If groundwater data demonstrate that the soil is not causing significant leaching, the MCSs for the metals in soil may be revised such that metals are no longer considered COCs.

5.5.3 Control the Source of Releases

There are no ongoing sources of releases at SWMU 8/AOC 636; therefore, this issue is not applicable.

5.5.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. This alternative does not generate any wastes that would require special management. Small quantities of purge water would be generated during routine sampling activities.

5.5.5 Other Factors

Long-term Reliability and Effectiveness

This alternative is expected to provide long-term reliability and effectiveness. The risk of failure is low, provided the LUCIP is enforced by the responsible entity.

Reduction in the Toxicity, Mobility, or Volume of Wastes

This alternative does not result in reduction of toxicity, mobility, or volume of impacted soil at SWMU 8/AOC 636.

Short-term Effectiveness

This alternative is expected to be effective in the short term. The Navy retains ownership and control of the site's use until LUCs are implemented. This alternative does not involve any site activities; thus, no short-term risks are created.

Implementability

This alternative is relatively easy to implement since it requires only the development of LUCs and an appropriate monitoring program.

Cost

Monitoring and LUCs are not costly to implement. Appendix B presents a summary of estimated costs for this alternative.

Using the assumptions described earlier, the total present value of this alternative is $34,000.

5.6 Soil Alternative: Excavation and Offsite Disposal

This alternative could apply to antimony in subsurface soil. The assumptions for the this alternative include the following:

- The subsurface soil in which antimony exceeds the SSL is adequately defined.
- The excavated soil is not a hazardous waste and can be disposed to a Subtitle D landfill as non-hazardous waste.

5.6.1 Protect Human Health and the Environment

This alternative is expected to be effective at protecting human health because it removes soil with elevated antimony concentrations from the site.

5.6.2 Attain Media Cleanup Standards

This alternative would achieve the MCSs for antimony in subsurface soil.

5.6.3 Control the Source of Releases

There are no ongoing sources of releases at SWMU 8/AOC 636; therefore, this issue is not applicable.

5.6.4 Comply with Applicable Standards for the Management of Generated Wastes

This alternative can be implemented in compliance with applicable standards and regulations. Excavated soil is not expected to exhibit characteristics of a hazardous waste and can likely be disposed to a Subtitle D landfill.

5.6.5 Other Factors

Long-term Reliability and Effectiveness

This alternative is expected to provide has long-term reliability and effectiveness.

Reduction in the Toxicity, Mobility, or Volume of Wastes

This alternative results in the reduction of mobility and volume of wastes at SWMU 8/AOC 636 by removing soil with elevated antimony from the site.

Short-term Effectiveness

This alternative is expected to be effective in the short term. The alternative would be effective as soon as the soil was removed.

Implementability

This alternative is relatively easy to implement, since it is conventional work and similar work has been completed many times at the CNC.

Cost

Appendix B presents the overall costs for this alternative. A scope contingency (20 percent) is added to cover additional costs during its execution. The costs include the following:

- Excavated soil is limited to the areas with antimony exceedances previously identified during the RFI.
- Application of 20 percent contingency for additional scope that may be required.

Using the assumptions described earlier, the total present value of this alternative is $41,000.

TABLE 5-1
Detailed Analysis of LNAPL and Groundwater Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/Alternatives	**Active LNAPL**	**Active LNAPL**	**Passive LNAPL**	**Groundwater - for PAHs and Antimony**
Evaluation Criteria	**Solar Powered Skimmer**	**Manual LNAPL Recovery**	**Absorbent Filters**	**Monitoring/Natural Attenuation/LUCs**
Protection Of Human Health and the Environment	Process will be protective of human health and the environment.	Process will be protective of human health and the environment.	Process will be protective of human health and the environment.	Process will be protective of human health and the environment.
Attainment of Media Cleanup Standards	It is expected that the alternative will meet MCSs.	It is expected that the alternative will meet MCSs.	It is expected that the alternative will meet MCSs. Used in wells with low volume of LNAPL.	Alternative can potentially attain MCSs, once LNAPL removal is complete (for PAHs), and provided soil is not leaching antimony into groundwater
Control of the Source of Release	Not applicable. There are no ongoing sources of releases at SWMU 8/AOC 636.	Not applicable. There are no ongoing sources of releases at SWMU 8/AOC 636.	Not applicable. There are no ongoing sources of releases at SWMU 8/AOC 636.	For PAHs, the source of PAHs is residual LNAPL which is being addressed separately and for antimony, subsurface soil (also addressed separately) may possibly be a residual source.
Compliance with Applicable Waste Management Standards	Recovered LNAPL will be sampled and analyzed for waste characterization parameters.	Recovered LNAPL will be sampled and analyzed for waste characterization parameters.	Recovered LNAPL will be sampled and analyzed for waste characterization parameters.	Not expected to accumulate significant quantities of waste requiring management.
Long-term Reliability and Effectiveness				
Magnitude of Residual Risk	Residual risk with exposure at the site reduced to minimal levels once LNAPL is recovered.	Residual risk with exposure at the site reduced to minimal levels once LNAPL is recovered.	Residual risk with exposure at the site reduced to minimal levels once LNAPL is recovered.	Gradual reduction of residual risk within dissolved-phase plume, resulting in adequate reduction in residual risk at the site.
Adequacy of Reliability of Controls	Expected to provide adequate control over the long term.	Expected to provide adequate control over the long term.	Expected to provide adequate control over the long term.	Monitoring will be adequate to manage exposure at the site.

TABLE 5-1
Detailed Analysis of LNAPL and Groundwater Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/Alternatives	Active LNAPL	Active LNAPL	Passive LNAPL	Groundwater - for PAHs and Antimony
Evaluation Criteria	**Solar Powered Skimmer**	**Manual LNAPL Recovery**	**Absorbent Filters**	**Monitoring/Natural Attenuation/LUCs**
Reduction of Toxicity, Mobility, or Volume of Wastes				
Amount of Hazardous Materials Anticipated to be Destroyed/Treated	If properly implemented, the alternative is expected to result in LNAPL removal to the MCS.	If properly implemented, the alternative is expected to result in LNAPL removal to the MCS.	If properly implemented, the alternative is expected to result in LNAPL removal to the MCS.	Variable. In conjunction with LNAPL recovery alternatives, and subsurface soil removal (for antimony, if necessary) MNA is expected to reduce dissolved-phase contaminants to their respective MCSs.
Degree and Quantity of Reduction	High. Alternative is expected to remove LNAPL to the extent possible.	High. Alternative is expected to remove LNAPL to the extent possible.	High. Alternative is expected to remove LNAPL to the extent possible.	Coupled with a LNAPL source recovery alternative and subsurface soil removal, if necessary, this alternative is expected to reduce dissolved-phase contaminants to MCSs.
Irreversibility of Reduction	High. LNAPL recovery is permanent.	High. LNAPL recovery is permanent.	High. LNAPL recovery is permanent.	High. Natural attenuation is permanent.
Type and Quantity of Treatment Residuals	Treatment residuals (LNAPL) are anticipated.	Treatment residuals (LNAPL) are anticipated.	Treatment residuals (LNAPL) are anticipated.	Minimal treatment residuals are anticipated.
Preference for Treatment as a Principal Element	Active treatment (recovery) is the principal component of this alternative.	Active treatment (recovery) is the principal component of this alternative.	Passive treatment (recovery) is the principal component of this alternative.	Natural treatment processes are provided by this alternative.
Short-term Effectiveness				
Protection of Workers During Remedial Action Construction	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.	Implementation poses a low degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.

TABLE 5-1
Detailed Analysis of LNAPL and Groundwater Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/Alternatives	Active LNAPL	Active LNAPL	Passive LNAPL	Groundwater - for PAHs and Antimony
Evaluation Criteria	**Solar Powered Skimmer**	**Manual LNAPL Recovery**	**Absorbent Filters**	**Monitoring/Natural Attenuation/LUCs**
Protection of Community During Remedial Action	Implementation poses a minimal degree of safety or health hazards to the CNC community.	Implementation poses a minimal degree of safety or health hazards to the CNC community.	Implementation poses a minimal degree of safety or health hazards to the CNC community.	Implementation poses a minimal degree of safety or health hazards to the CNC community.
Environmental Impacts of Remedial Action	Process should not create adverse impacts on the environment.	Process should not create adverse impacts on the environment.	Process should not create adverse impacts on the environment.	Process should not create adverse impacts on the environment.
Implementability				
Technical Feasibility	High. Alternative uses industry proven and readily available technology.	High. Alternative uses industry proven and readily available technology.	High. Alternative uses industry proven and readily available technology.	High. Process uses conventional and readily available technology.
Administrative Feasibility	High. Few major administrative issues are expected.	High. Few major administrative issues are expected.	High. Few major administrative issues are expected.	High. Few major administrative issues are expected.
Total Cost	$34,000	30,000	$13,400	$44,000

[a] Order-of-magnitude level cost estimates with expected accuracy of plus 50 to minus 30 percent.

[b] Assumes percent interest and a 5-year operation period.

[c] Assumes percent interest and a 20-year operation period.

TABLE 5-2
Detailed Analysis of Soil Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/ Alternatives	Surface Soil - Aroclor 1260 and Thallium	Subsurface Soil - Antimony
Evaluation Criteria	**LUCs/GW monitoring**	**Soil Excavation**
Protection Of Human Health and the Environment	Process will be protective of human health and the environment.	Process will be protective of human health and the environment.
Attainment of Media Cleanup Standards	This alternative will not meet the unrestricted MCS for Aroclor 1260. If thallium is found to not leach to groundwater, it will be dropped as a COC.	This alternative will meet the MCS.
Control of the Source of Release	Not applicable. There are no ongoing sources of releases at SWMU 8/AOC 636.	Not applicable. There are no ongoing sources of releases at SWMU 8/AOC 636.
Compliance with Applicable Waste Management Standards	This alternative can be implemented in compliance with applicable waste management standards.	This alternative can be implemented in compliance with applicable waste management standards.
Long-term Reliability and Effectiveness		
Magnitude of Residual Risk	This alternative will control exposure to COCs and thus provides adequate risk management.	This alternative provides for removal of antimony and thus provides adequate risk management.
Adequacy of Reliability of Controls	Expected to provide adequate control over the long term.	Expected to provide adequate control over the long term.
Reduction of Toxicity, Mobility, or Volume of Wastes		
Amount of Hazardous Materials Anticipated to be Destroyed/Treated	Minimal destruction of hazardous materials expected to be treated or destroyed.	Minimal destruction of hazardous materials expected to be treated or destroyed.
Degree and Quantity of Reduction	Minimal	Minimal
Irreversibility of Reduction	N/A	N/A
Type and Quantity of Treatment Residuals	N/A	N/A
Preference for Treatment as a Principal Element	N/A	N/A
Short-term Effectiveness		
Protection of Workers During Remedial Action Construction	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan.	Implementation poses a minimal degree of safety and health hazards to workers. Requires a Site Health and Safety Plan. This remediation alternative has been safely implemented on previous occasions at the CNC.

TABLE 5-2
Detailed Analysis of Soil Corrective Measure Alternatives
Corrective Measures Study Report, SWMU 8/AOC 636, Zone G, Charleston Naval Complex

Media/ Alternatives	Surface Soil - Aroclor 1260 and Thallium	Subsurface Soil - Antimony
Evaluation Criteria	**LUCs/GW monitoring**	**Soil Excavation**
Protection of Community During Remedial Action	Implementation poses a minimal degree of safety or health hazards to the CNC community.	Implementation poses a minimal degree of safety or health hazards to the CNC community.
Environmental Impacts of Remedial Action	Process should not create adverse impacts on the environment.	Process should not create adverse impacts on the environment.
Implementability		
Technical Feasibility	High.	High. Alternative uses industry proven and readily available technology.
Administrative Feasibility	High. Few major administrative issues are expected.	High. Few major administrative issues are expected.
Total Cost	Included under LUC/MNA alternative	$41,000

[a] Order-of-magnitude level cost estimates with expected accuracy of plus 50 to minus 30 percent.

[b] Assumes percent interest and a 5-year operation period.

[c] Assumes percent interest and a 20-year operation period.

Section 6.0

6.0 Recommended Corrective Measure Alternatives

Based on the preceding evaluation of available viable technologies and conditions at SWMU 8/AOC 636, the following corrective measures alternatives are recommended.

6.1 LNAPL

Manual LNAPL recovery is recommended for sump G008GSP04. Manual LNAPL recovery was selected over a solar-powered LNAPL recovery unit because manual recovery is less expensive and just as effective. Manual LNAPL recovery will be implemented weekly initially for the one or two months to assess the speed and degree to which additional LNAPL moves into the sump after removal. After this initial period, if the recovery rate is found to significantly decrease, a biweekly removal may be appropriate. It is expected that a field team of two people will implement this recovery using a portable generator-driven pump and hoses. The recovered LNAPL will be stored in drums for subsequent further analysis and disposal.

Passive LNAPL recovery using adsorbent pads is recommended for G008GSP11. The LNAPL pads will be inspected during the LNAPL recovery operations at G008GSP04 and replaced as necessary.

6.2 Groundwater — PAHs and Antimony

MNA for PAHs and antimony is recommended. It is expected that LNAPL recovery will remove the source of PAHs in groundwater. Additional monitoring for antimony will indicate whether antimony continues to be elevated in groundwater, whether antimony concentrations are increasing, stable, or decreasing and whether additional subsurface soil remediation for antimony should be considered. A MNA sampling plan is required and will be prepared and submitted separately.

6.3 Surface Soil — Aroclor-1260 and Thallium

LUCs are recommended for Aroclor-1260 and thallium in surface soil with periodic groundwater sampling for thallium to confirm it is not leaching into groundwater. Given the lack of groundwater impacts to date from leaching of thallium from soil, it is expected that thallium may be dropped as a COC after several confirmatory groundwater sampling events confirms it is continuing to not leach. Aroclor-1260 is a COC only for the unrestricted land use scenario and LUCs restricting the site to non-residential use will be implemented.

6.4 Subsurface Soil — Antimony and Thallium

No action at this time other than the long term groundwater monitoring described above is recommended for thallium and antimony in subsurface soil. Should the long-term monitoring indicate that thallium or antimony in subsurface soil is impacting groundwater, further corrective measures, such as subsurface soil excavation in areas of elevated metals, should be considered as a contingent remedy. If the results indicate that leaching of metals to groundwater is not an issue at the site, then either or both of these metals may be dropped as a subsurface soil COC.

Section 7.0

7.0 References

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Appendix A

Products

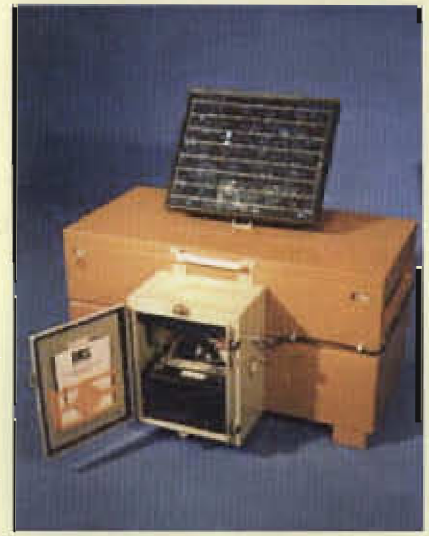
ENVIRONMENTAL SERVICES

Model Descriptions

The Solar Sentinel®

The Free Phase Hydrocarbon Skimmer System

Parker Systems, Inc.



Available with solar powered 12V DC operation, 115V AC operation or both solar powered 12V DC and 115V AC operation. Comes with a 2-inch or 4-inch free product skimmer and is self-contained in a weatherproof security enclosure.

MODEL FPS-12 Solar powered 12V DC operation. Used for shallow wells where the depth to product is less than 25 feet.	**MODEL FPS-12DW** Solar powered 12V DC operation. Used for deep wells where the depth to product is more than 25 feet.
MODEL FPS-115 115V AC powered. Used for shallow wells.	**MODEL FPS-115DW** 115V AC powered. Used for deep wells.
MODEL FPS-12/115 Solar powered 12V DC operation or 115V AC powered. Used for shallow wells.	**MODEL FPS-12/115DW** Solar powered 12V DC operation or 115V AC powered. Used for deep wells.

Advantages

- No external electrical power required (FPS-12, FPS-12DW).
- Small and unobtrusive.
- Installation is quick and easy.
- Low maintenance.
- Excellent for pilot studies, initial abatement, remote sites.
- System installation requires no trenching (i.e., driveway and parking area installation with little or no disruption to business).
- Economical alternative to manual bailing or permanent system.
- Secure, tamper proof heavy gauge steel enclosure.
- Can pump from 2 wells simultaneously.
- Optional 240-gallon double-wall holding tank available as shown.

Trailer mounted systems available.

For more information call :
IMS Environmental Services
(757) 436-3000 or fax (757) 436-5266

Custom designs available upon request.

Appendix B

TOTAL COST OF REMEDIAL SOLUTION
LNAPL, Groundwater, and Soil Corrective Action Alternatives

Site:	Charleston Naval Complex	**Base Year:**	2003
Location:	SWMU 8/AOC 636	**Date:**	06/09/03
Phase:	Corrective Measures Study		

	Active LNAPL Alternative **Solar Powered Skimmer**	Passive LNAPL Alternative **Absorbent Filters**	Manual LNAPL Alternative **Manual Pumping**	Groundwater Alternative **Monitoring/ Natural Attenuation**	Soil Alternative[1] **Land Use Controls/ Groundwater Monitoring**	Soil Alternative[2] **Soil Excavation and Offsite Disposal**
Total Project Duration (Years)	5	5	5	5	20	20
Capital Cost	$11,100	$400	$2,100	$12,400	$10,000	$41,000
Annual O&M Cost	$8,000 (Year 1 -3)	$4602 (Year 1 - 3)	$10,000 (Year 1-3)	$7,000 (Year 1 - 5)	$1,100 (Year 1 - 20) $4,300 (Years 3,5,7)	
Total Present Worth of Solution	$34,000	$13,400	$30,000	$44,000	$34,000	$41,000

Disclaimer: The information in this cost estimate is based on the best available information regarding the anticipated scope of the remedial alternatives. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. This is an order-of-magnitude cost estimate that is expected to be within -30 to +50 percent of the actual project costs.

[1] Groundwater monitoring with the LUC alternative is proposed to evaluate potential leaching due to elevated concentrations of thallium in surface soil and antimony and thallium in subsurface soil.
[2] Soil excavation is targeted for antimony in subsurface soil. Alternative does not provide O&M costs for LUCs and groundwater monitoring required for remaining surface and subsurface soil contaminants.

Active LNAPL Recovery Alternative	**Solar Powered Skimmer**	**COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex

Description: Active LNAPL recovery using a solar powered skimmer

Location: SWMU 8/AOC 636
Phase: Corrective Measures Study
Base Year: 2003
Date: 05/01/03

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Solar Powered Skimmer	1	EA	$7,500	$7,500	Estimate Provided by IMS Environmental - Use in one well location
Waste Characterization Analysis	1	EA	$450	$450	TCLP metals, hydrogen, and sulfur
Field Implementation					Installation in one day
Labor - Site Superintendent	8	HR	$40	$320	
Labor - Field Engineer	8	HR	$30	$240	
Labor - Procurement Manager	4	HR	$30	$120	
SUBTOTAL				**$8,630**	
Project Management	2%	of	$8,630	$173	
Technical Support	3%	of	$8,630	$259	
Construction Management	0%	of	$8,630	$0	
Subcontractor General Requirements	2%	of	$8,630	$173	
SUBTOTAL				**$9,234**	
Contingency	20%	of	$9,234	$1,847	
TOTAL CAPITAL COST				**$11,100**	

Cost for preparation of Corrective Measure Implementation Plan and Monitoring/ Natural Attenuation Work Plan is provided in the cost estimate for MNA

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
LNAPL Recycling/Treatment	288	GAL	$0.15	$43	
Transportation to Recycling/Treatment Facility	6	EVENT	$230	$1,380	Six 55-gallon drums of LNAPL
Annual Management and Field Labor					
Labor - Engineer/Hydrogeologist	32	HR	$60	$1,920	
Labor - Field Engineer	72	HR	$65	$4,680	
SUBTOTAL				**$8,023**	
TOTAL ANNUAL O&M COST				**$8,000**	

Cost for preparation of Annual Report is provided in the cost estimate for MNA

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT WORTH	NOTES
1	FIRST YEAR CAPITAL COST	$11,100	$11,100	$11,100	
1 - 3	ANNUAL O&M COST (Year 1 - 3)	$8,000	$8,000	$22,542	
				$33,642	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$34,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000)

Passive LNAPL Recovery Alternative **Absorbent Filters** | **COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex | **Description:** Passive LNAPL recovery using absorbent filters

Location: SWMU 8/AOC 636
Phase: Corrective Measures Study
Base Year: 2003
Date: 05/01/03

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Absorbent LNAPL Filters	2	Boxes	$91	$182	Estimate Provided by New Pig - 25 Skimmers/ Box (EA - 3-inch diameter by 18 inches long)
Field Implementation	4	HR	$30	$120	
SUBTOTAL				**$302**	
Project Management	0%	of	$302	$0	
Technical Support	0%	of	$302	$0	
Construction Management	0%	of	$302	$0	
Subcontractor General Requirements	20%	of	$302	$60	
SUBTOTAL				**$362**	
Contingency	20%	of	$362	$72	
TOTAL CAPITAL COST				**$400**	

Cost for preparation of Corrective Measure Implementation Plan and Monitoring/ Natural Attenuation Work Plan is provided in the cost estimate for MNA
Cost for waste characterization analysis and field implementation is provided in the cost estimate for active LNAPL recovery (i e , Solar Powered Skimmer)

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
O&M Cost - Years 1 - 4					
Absorbent LNAPL Filters	2	Boxes	$91	$182	25 Skimmers/ Box (EA - 3-inch diameter by 18 inches long)
Field Implementation	104	HR	$40	$4,160	4 hrs/event, 26 events/yr
Absorbent Filter Disposal - Subtitle D Landfill	1	DRUM	$30	$30	50 absorbent filters/drum
Transportation to Recycling/Treatment Facility	1	EVENT	$230	$230	One 55-gallon drum of absorbent filters
SUBTOTAL				**$4,602**	
TOTAL ANNUAL O&M COST YEARS 1 - 4				**$4,600**	
O&M Cost - Year 5					
Absorbent Filter Disposal - Subtitle D Landfill	1	DRUM	$30	$30	50 absorbent filters/drum
Field Implementation	104	HR	$40	$4,160	4 hrs/event, 26 events/yr
Transportation to Recycling/Treatment Facility	1	EVENT	$230	$230	One 55-gallon drum of absorbent filters
SUBTOTAL				**$4,420**	
TOTAL ANNUAL O&M COST YEAR 5				**$4,420**	

Cost for preparation of Annual Report is provided in the cost estimate for MNA
Cost for annual management and field labor is provided in the cost estimate for active LNAPL recovery (i e , Solar Powered Skimmer)

PRESENT VALUE ANALYSIS

Discount Rate = 3 2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT WORTH	NOTES
1	FIRST YEAR CAPITAL COST	$400	$400	$400	
1 - 3	ANNUAL O&M COST (Year 1 - 3)	$4,600	$4,600	$12,962	
				$13,362	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$13,400**	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002 (USEPA, 2000)

Active LNAPL Recovery Alternative | **Manual LNAPL Recovery** | **COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex

Description: Manual LNAPL recovery using a pumps and/or bailers

Location: SWMU 8/AOC 636
Phase: Corrective Measures Study
Base Year: 2003
Date: 05/01/03

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Waste Characterization Analysis	1	EA	$450	$450	TCLP metals, hydrogen, and sulfur
Field Implementation					Installation in one day
Labor - Site Superintendent	8	HR	$40	$320	
Labor - Field Engineer	8	HR	$30	$240	
Labor - Procurement Manager	4	HR	$30	$120	
LNAPL Recovery Equipment	1	LS	$600	$600	Pump, hoses, instrumentation
SUBTOTAL				**$1,730**	
Project Management	0%	of	$1,730	$0	
Technical Support	0%	of	$1,730	$0	
Construction Management	0%	of	$1,730	$0	
Subcontractor General Requirements	0%	of	$1,730	$0	
SUBTOTAL				**$1,730**	
Contingency	20%	of	$1,730	$346	
TOTAL CAPITAL COST				**$2,100**	

Cost for preparation of Corrective Measure Implementation Plan and Monitoring/ Natural Attenuation Work Plan is provided in the cost estimate for MNA

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
LNAPL Recycling/Treatment	288	GAL	$0.15	$43	
Transportation to Recycling/Treatment Facility	6	EVENT	$230	$1,380	Six 55-gallon drums of LNAPL
Annual Management and Field Labor					
Labor - Engineer/Hydrogeologist	52	HR	$60	$3,120	2 hrs/event and 26 events/yr
Labor - Field Engineer	82	HR	$65	$5,330	Same as above plus 30 hrs/yr
SUBTOTAL				**$9,873**	
TOTAL ANNUAL O&M COST				**$10,000**	

Cost for preparation of Annual Report is provided in the cost estimate for MNA

PRESENT VALUE ANALYSIS

Discount Rate = 3 2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT WORTH	NOTES
1	FIRST YEAR CAPITAL COST	$2,100	$2,100	$2,100	
1 - 5	ANNUAL O&M COST (Year 1 - 5)	$10,000	$10,000	$28,178	
				$30,278	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$30,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000).

Groundwater Alternative	Monitoring/Natural Attenuation	COST ESTIMATE SUMMARY

Site: Charleston Naval Complex

Location: SWMU 8/AOC 636

Phase: Corrective Measures Study

Base Year: 2003

Date: 05/01/03

Description: Monitoring/natural attenuation of dissolved PAHs and Antimony in the surficial aquifer

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Corrective Measure Implementation Plan/ Monitoring/Natural Attenuation Work Plan					
Labor - Engineer/Hydrogeologist	28	HR	$55	$1,540	
Labor - Editor	16	HR	$60	$960	
Labor - CAD Technician	8	HR	$60	$480	
Labor - CIH	8	HR	$85	$680	
Initial Monitoring/Natural Attenuation Groundwater Sample Collection Event	1	EA	$5,300	$5,300	
SUBTOTAL				**$8,960**	
Project Management	5%	of	$8,960	$448	
Technical Support	5%	of	$8,960	$448	
Construction Management	0%	of	$8,960	$0	
Subcontractor General Requirements	5%	of	$8,960	$448	
SUBTOTAL				**$10,304**	
Contingency	20%	of	$10,304	$2,061	
TOTAL CAPITAL COST				**$12,400**	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Groundwater Sample Collection Event	1	EA	$5,300	$5,300	Sample 9 Existing Monitoring Wells and/or Groundwater Sumps
Annual Report					
Labor - Engineer/Hydrogeologist	16	HR	$55	$880	
Labor - Editor	10	HR	$60	$600	
Labor - CAD Technician	4	HR	$60	$240	
SUBTOTAL				**$7,020**	
TOTAL ANNUAL O&M COST				**$7,000**	

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	TOTAL PRESENT WORTH	NOTES
1	FIRST YEAR CAPITAL COST	$12,400	$12,400	$12,400	
1 - 5	ANNUAL O&M COST (Year 1 - 5)	$7,000	$7,000	$31,876	Annual Sampling Event
				$44,276	
	TOTAL PRESENT WORTH OF ALTERNATIVE			**$44,000**	

SOURCE INFORMATION

1 United States Environmental Protection Agency July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002 (USEPA, 2000)

Soil Alternative | **Land Use Controls with Groundwater Monitoring** | **COST ESTIMATE SUMMARY**

Site: Charleston Naval Complex

Location: SWMU 8/AOC 636
Phase: Corrective Measures Study
Base Year: 2003
Date: 05/01/03

Description: Implementation of base-wide land use management plan to put institutional controls in place to restrict site use to commercial/industrial. As part of this alternative monitoring events are scheduled every other year to evaluate soil contaminant leaching.
Assumes this site is part of a multi-site implementation, and costs are shared among all the sites.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Groundwater Monitoring Event	1	EA	$3,200	$3,200	Monitoring to evaluate soil inorganic leaching
Deed Restrictions - Attorney	4	HR	$200	$800	
Record Deed	4	EA	$500	$2,000	
LUC Implementation	24	HR	$75	$1,800	
SUBTOTAL				$7,800	
Project Management	10%		$7,800	$780	USEPA 2000, p 5-13, <$100K
Remedial Design	0%		$7,800	$0	Not applicable.
Construction Management	0%		$7,800	$0	Not applicable.
SUBTOTAL				$8,580	
Contingency	20%		$8,580	$1,716	
TOTAL CAPITAL COST				$10,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Annual Groundwater Monitoring Event	1	event	$900	$900	
SUBTOTAL				$900	
Allowance for Misc. Items	20%		$900	$180	
SUBTOTAL				$1,080	
TOTAL ANNUAL O&M COST				$1,100	

Cost for preparation of Annual Report is provided in the cost estimate for MNA

PRESENT VALUE ANALYSIS

Discount Rate = 3.2%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	PRESENT VALUE	NOTES
1	FIRST YEAR CAPITAL COST	$10,000	$10,000	$10,000	
3, 5, 7	ANNUAL O&M COST DURING MONITORING YEARS	$4,300	$4,300	$24,279	Assumes 3 monitoring events
1, 2, 4, 6, 8-20	ANNUAL O&M COST W/O MONITORING	$1,100	$1,100		
				$34,279	
	TOTAL PRESENT VALUE OF ALTERNATIVE			$34,000	

SOURCE INFORMATION

1. United States Environmental Protection Agency. July 2000. A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study. EPA 540-R-00-002. (USEPA, 2000)

Alternative: **Soil Excavation and Offsite Disposal with LUCs** **COST ESTIMATE SUMMARY**
Elements:

Site: Charleston Naval Complex
Location: SWMU 8/AOC 636
Phase: Corrective Measures Study
Base Year: 2003
Date:

Description: Excavation of antimony impacted subsurface soil, disposal offsite at permitted landfill, backfill with clean soil. Extent includes RFI sample points plus 20% scope contingency.

CAPITAL COSTS

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
Soil Excavation - Antimony in Subsurface Soil					
Confirmation Sampling	1	EA	$5,100	$5,100	See Confirmation Worksheet
Removal, Disposal and Backfill	1	EA	$22,000	$22,000	See Site Excavation Worksheet
SUBTOTAL				$27,100	
Contingency	20%		$27,100	$5,420	
SUBTOTAL				$32,520	
Project Management	5%		$32,520	$1,626	
Remedial Design	10%		$32,520	$3,252	
Construction Management	10%		$32,520	$3,252	
SUBTOTAL				$8,130	
TOTAL CAPITAL COST				$41,000	

OPERATIONS AND MAINTENANCE COST

DESCRIPTION	QTY	UNIT	UNIT COST	TOTAL	NOTES
SUBTOTAL				$0	
Allowance for Misc. Items	20%		$0	$0	
SUBTOTAL				$0	
TOTAL ANNUAL O&M COST				$0	

PRESENT VALUE ANALYSIS

Discount Rate = 7%

End Year	COST TYPE	TOTAL COST	TOTAL COST PER YEAR	PRESENT VALUE	NOTES
0	CAPITAL COST	$41,000	$41,000	$41,000	
	ANNUAL O&M COST	$0	$0	$0	
				$41,000	
	TOTAL PRESENT VALUE OF ALTERNATIVE			$41,000	

SOURCE INFORMATION

1 United States Environmental Protection Agency. July 2000 A Guide to Preparing and Documenting Cost Estimates During the Feasibility Study EPA 540-R-00-002. (USEPA, 2000).